

PILOT STUDY OF PLYWOOD DISTRIBUTION
AND USE IN THE PHOENIX TRADE AREA

By

A. G. Madsen and T. E. Kleinschmit
Department of Economics, Colorado State University
Fort Collins, Colorado

in cooperation with
Rocky Mountain Forest and Range Experiment Station
U.S. Forest Service, U.S. Department of Agriculture

Research Report for project entitled
"End Use Requirements for Plywood in the
Phoenix, Arizona Trade Area"

April, 1969

LIBRARY COPY
ROCKY MT. FOREST & RANGE
EXPERIMENT STATION

PILOT STUDY OF PLYWOOD DISTRIBUTION
AND USE IN THE PHOENIX TRADE AREA

By

A. G. Madsen and T. E. Kleinschmit
Department of Economics, Colorado State University
Fort Collins, Colorado

in cooperation with
Rocky Mountain Forest and Range Experiment Station
U.S. Forest Service, U.S. Department of Agriculture

Research Report for project entitled
"End Use Requirements for Plywood in the
Phoenix, Arizona Trade Area"

April, 1969

TABLE OF CONTENTS

Introduction	1
The Industry in Brief	1
Review of Other Studies	2
Methodology	7
Study Phase One	7
Analysis of Data Collected in Study Phases One and Two	11
Response to Mailed Questionnaires	11
Reasons for Nonresponse	14
Findings	15
Principle Contractors of Apartment and Nonresidential Construction	17
Types of Construction	17
Plywood Use by Different Size Firms	19
Sources of Plywood Supply	20
Distribution of Plywood Among the Various Types of Construction	23
Specific End Uses for Softwood Plywood	31
Statistical Difference Between Mail Questionnaire Returns and Personal Interview Returns	38
Plywood Used by Subcontractors of Apartment and Nonresidential Construction	41
Sources of Plywood Used	42
Types of Construction for Which Plywood Was Used	44
Specific End Uses for Softwood Plywood	44
Specific End Uses for Hardwood Plywood	47
Significance of the Difference Between Mail Questionnaire Returns and Personal Interviews Returns	47
Construction and Plywood Use by Principal Contractors of Single Family Homes	47
Number of Houses Built By Price Class	48
Types of Houses Built	48
Test of Significance of the Difference Between The Two Samples with Respect to Type of Houses Built	50
Construction Characteristics of Houses	51
Volumes and Sources of Softwood Plywood Used	51
Volumes and Sources of Hardwood Plywood Used	54
Specific Applications of Softwood Plywood	56
Tests of the Significance of the Difference Between The Two Samples	58
Plywood Used by Subcontractors of Single Family Homes	59
Types of Work Done by Subcontractors	60
Amounts of Softwood Plywood Used in Specific Applications	60
Significance of the Difference Between the Mail Sample and the Personal Interview Sample	61
Specific Applications for Hardwood Plywood	63
Sources of Plywood	63
Plywood Used by Manufacturers	65

Sources of Plywood Used By Manufacturers	65
Amounts of Plywood Used by End Use	66
Plywood Distribution by Wholesale and Retail Lumber Dealers	68
Amounts of Softwood Plywood Handled	68
Sources of Softwood Plywood Handled	70
Sources of Hardwood Plywood Handled	70
Disposal of Plywood	73
Where Plywood was Sold By Dealers	74
Groups to Whom Plywood Was Sold Inside the Study Area	75
Softwood Consumption in the Phoenix Major Trade Area	77 79
Study Phase Three	81
Reasons for Using Materials in Different End Uses	
Roof Sheathing Materials	82
Wall Sheathing Materials	86
Soffit Materials	87
Exterior Siding Material	88
Subflooring Material	88
Underlayment Material	89
Finish Flooring Material	89
Formwork Material	90
Interior Paneling Materials	91
Cabinet Work Materials	91
Shelving and Mill Work Materials	91
Most Common Objections to and Recommendations for Improving Plywood	93
Intentions for Future Material Use	95
Study Phase Four	
Depth Interview of Panel Groups	97
Findings from Panel Interviews	98
Discussion of Specific End Uses for Building Materials	100
Formwork	100
Roof Sheathing	101
Wall Sheathing	101
Exterior Siding	102
Underlayment	104
Conclusions	104
Recommendations for Gathering Quantitative Data	106
Critique of Personal Interviews to Obtain Qualitative Data	107
Critique of the Panel Group Interview Method	108
Bibliography	110
Appendix I Interview Questionnaire	111

Appendix II	Percents and Amounts of Hardwood Plywood Used in Nonresidential and Apartment Construction by Size Classes of Contractors, Arizona, 1966.	127
Appendix III	Ninety Percent Confidence Intervals for the Amounts of Softwood Plywood Used in Specific End Uses by Principal Contractors of Apartment and Non Residential Construction, Arizona, 1966.	130
Appendix IV	Results of Tests of Significance of the Difference of the Populations from Which the Mail Sample and the Personal Interview Sample Were Taken	133
Appendix V	Specific End Uses for Hardwood Plywood in Apartment and Nonresidential Construction by Size Classes of Principal Builders, Arizona, 1966.	134
Appendix VI	Confidence Intervals Ninety Percent Confidence Intervals for the Amounts of Softwood Plywood Used in Specific End Uses by Subcontractors, Arizona, 1966.	135
Appendix VII	Specific End Uses for Hardwood Plywood in Apartment and Nonresidential Construction by Subcontractors.	136
Appendix VIII	Sources of Hardwood Plywood Used by Principal Contractors of Single Family Homes, Arizona, 1966.	137
Appendix IX	Ninety Percent Confidence Intervals for the Amounts of Softwood Plywood Used in Specific End Uses by Principal contractors of Single Family Home Construction, Arizona, 1966.	138
Appendix X	Specific End Uses for Hardwood Plywood in Single Family Home Construction by Subcontractors, Arizona, 1966.	140

INTRODUCTION

Large amounts of forest resources exist in the United States, but the major portion of these will provide only relatively low quality wood products. There are certain uses for plywood which can utilize these resources if a market can be identified and exploited. The development of these forest resources can provide employment in many of the depressed rural areas in the United States. Prior to increasing production capacity for any product, however, it is usually sound economics to have some estimate of demand for the product and to identify characteristics which are advantageous or weaknesses relative to competing products. Studies of this type will serve as a guide in making production and marketing decisions.

In 1967 and 1968, a study was conducted for the United States Forest Service (1) to determine the movements of known quantities of plywood through the marketing system, (2) to determine the end uses of plywood, and (3) to estimate the volume of plywood being used in the major end uses, and the competitive position of plywood in each of these uses. An additional objective was to identify the qualitative factors which explain the reasons for using plywood or its competing products. This was a pilot project designed to test methodologies appropriate for data collection and analysis and to design mail and personal interview questionnaires.

Since the first phase of this project was started in mid 1967 and the field work was completed for the final phase in September 1968, the latest full year of data were available for 1966.

THE INDUSTRY IN BRIEF

It has been estimated that about 50 percent of total plywood production

goes into residential construction.¹ Since residential construction is such a large source of demand for plywood and plywood products, there is a need to find new applications for plywood and produce a product which serves in the existing applications competitively with other materials. Evidence of this close relationship was the decrease in demand for plywood when investment for residential construction decreased from \$26.3 billion in 1965 to \$23.8 billion in 1966.²

Production of plywood at the end of World War II was 1.5 billion sq. ft. and since that time output has increased at an annual rate of 13 percent.³ By 1960 the level of plywood production has increased by over 1 billion sq. ft. per year. During 1965 it was projected that 1966 output would reach over 13 billion sq. ft. of this total about 65 million sq. ft. was shipped into the Phoenix major trade area.

REVIEW OF OTHER STUDIES

Considerable amounts of work and research have been done concerning the plywood industry. Studies conducted by the United States Department of Agriculture and various organizations of plywood producers have attempted to look at the various aspects of the industry in depth to determine more about production and flows of plywood. Most of these studies have been

¹D. F. P. A., A Study of Markets and Uses for Softwood Plywood, Vol. I & II, February, 1963, pp. 27-28.

²U. S. Department of Commerce, Supplement to Survey of Current Business, Business Statistics, 1967, Biennial Edition, Office of Business Economics, pp. 48-53.

³U. S. Department of Commerce, U. S. Industrial Outlook, 1966, Business and Defense Services Administration, December, 1965, pp. 20-22.

concentrated in one segment of the plywood industry such as plywood usage in the various types of construction or market share analysis of the position of plywood among the competing materials for a specific end-use. Other studies have attempted to estimate such things as the average amount of plywood used in a particular type of house for each of the major end-uses. Also, most of the studies are based on a nationwide sampling technique of contacting a pre-determined number of different types of plywood users and distributors. Studies of this type usually contact only a very small number of the total firms actually engaged in a type of construction or manufacturing carried on throughout the United States. These studies give some indication of differences from one part of the country to the next, however, the size of the population from which sampling is done is so large that many details may be overlooked. General trends are the most noticeable result. In this study all known plywood users were contacted.

One study analyzed the applications for all wood products used in the construction of single family homes inspected by Federal Housing Administration authorities between 1959 and 1962.⁴

A study conducted by the Douglas Fir Plywood Association during 1962 and 1963 sheds further light on the plywood market. This study⁵ was undertaken to determine the amount of plywood manufactured and distributed to the different types of users and purposes for which the plywood was used. Another aspect of the study was to determine the

⁴U. S. D. A. Forest Service, Wood Products Used in Single-Family Houses Inspected by the Federal Housing Administration, 1959 & 1962, Statistical Bulletin No. 366, March, 1966, pp. 8 and 9.

⁵Op. Cit. Douglas Fir Plywood Association.

requirements desired in a material in order for it to serve efficiently in a specific end-use.

The scope of the study was nationwide in the sense that it contacted builders in nearly every major trade area. However, the number of firms contacted in each area was a very small proportion of the total number in the area. The result was that the study showed very general trends and no specific information about the flows of plywood from the mills to ultimate users.

Some of the results of the study show that in 1962 nearly 50 percent of the plywood volume accounted for went into residential construction. Another 16 percent went to nonresidential construction and 22 percent went to industrial users.

Of the total amount of plywood going to residential builders the study discovered a breakdown of the total market for a specific end-use that does to plywood. In this case, plywood held 63 percent of the market for roof sheathing, 13 percent for wall sheathing, 34 percent for subflooring and 40 percent for underlayment. In contrast to this it was found that 37 percent of the market for roof decking in nonresidential construction was held by plywood.

A much closer look was taken at the industrial market for plywood in a study published by the U. S. Department of Agriculture.⁶ This was a study of the use of all wood products in manufacturing industries during

⁶U. S. D. A., Forest Service, Wood Used in Manufacturing Industries, Statistical Bulletin 353, February, 1965, pp. 11 and 13.

1960, and it was nationwide in scope. It showed that 2.8 billion sq. ft. of plywood was used in manufacturing wood products. This constituted 31 percent of the plywood used for all purposes during 1960.⁷

Of the total amount used in manufacturing, about 96 percent was consumed in products which were made for sale. The remainder went for items that were used by the manufacturer such as packaging and containers.

Further studies of the plywood industry have, in at least several instances, involved the use of econometric and computer simulation models of the industry. One such study⁸ has defined the industry in terms of seven interdependent sectors that represent the plywood industry from producers--both independent mills and mills integrated with wholesale warehouses--through the wholesale sector--consisting of independent jobbers,⁹ jobbers integrated with producers, and office wholesalers¹⁰--to the retail level consisting of those who buy in box-car-loads and those who buy in less than box-car-loads.

An econometric model of the relationships between supply and demand in the plywood industry described by Simpson.¹¹ This work was an attempt

⁷ Ibid., p. 13.

⁸ Manetsch, T. J., Simulation and Systems Analysis of the U. S. Softwood Plywood Industry, Ph. D. Thesis, Oregon State University, 1965 Abstract.

⁹ Jobbers are defined as wholesalers who actually have title to and physical possession of the plywood they sell.

¹⁰ Office wholesalers do not physically hold the plywood they sell.

¹¹ Simpson, R. S., An Econometric Analysis of Demand and Supply Relationships in the Douglas Fir Plywood Industry, Masters Thesis, Oregon State University, 1963, Abstract.

to discover and analyze the effects of important factors which influence supply and demand at the producing level with the intention of predicting market behavior. Five-equation models were developed to represent the sanded and unsanded plywood markets. Variables in the system were quarterly plywood price, production, new orders, unfilled orders, and wholesale inventories. From this model various factors influencing supply and demand relationships were determined.

Competitiveness of the plywood industry has been explored by Petit.¹² His conclusions were that since the beginning of the industry, it has progressed to a point where it can now be called "workably competitive." His conclusion is based on several criteria: resource allocation, productive efficiency, profit rate and selling costs in which the industry rates fairly well; progressiveness which is mediocre; and conservation which has been rather weak. On this basis the industry is determined to be competitive.¹³

In view of this type of structure within the industry there are a number of efforts by firms to find new uses for their product and to encourage the utilization of plywood in these new uses. One such attempt was made by U. S. Plywood when it started in the construction phase of plywood usage and developed housing tracts consisting of nearly all plywood.¹⁴ Motivation for this step was that by structurally designing and experimentally building homes they could incorporate plywood into the structures in extraordinary ways. They sought architectural designs which would make use of more plywood per house. It was hoped that changes in home construction trends could be initiated in this way.

¹²Petit, T. A., "The Value of Competition," in Journal of Industrial Economics, Vol. VI, 1957.

¹³Ibid., p. 43.

¹⁴"U. S. Plywood Shoots for Total Product Use," in Forest Industries Journal, Vol. LXXXIXIII No. 1, January, 1966, pp. 80-83.

METHODOLOGY

Since one of the objectives of the study was to develop a study method for determining the flows of plywood and the applications for it, it was desirable to select a relatively isolated trade area. The Phoenix area was chosen for this reason and for several other reasons. The trade area as defined by Rand-McNally¹⁵ includes all of Arizona with the exception of Apache and Mohave counties, so the size of the various populations under consideration in the particular area are of manageable proportions. Also, the Phoenix area is included in the administrative jurisdiction of the Rocky Mountain Forest and Range Experiment Station.

STUDY PHASE ONE

The scope of the first phase of the study was to contact, by means of mail questionnaires, all plywood consuming units in the area plus all the wholesale and retail dealers who handled plywood. Lists of wholesale and retail lumber dealers, principal contractors and subcontractors of residential, apartment, and nonresidential construction, prefabricated home manufacturers, mobile home manufacturers and manufacturers of products using wood were compiled from Dun & Bradstreet Reference Book concerning the Phoenix major trade area. These lists were supplemented from membership lists of the Arizona Retail Lumber and Builders Supply Association, the Home Builders Association of Central Arizona, Dun & Bradstreet Middle Market Directory, Dun & Bradstreet Million Dollar Directory, and Dun's Market Identifiers. A significant number of names were added to the list by referencing the advertizing section of local

¹⁵Trading Area Manual; Rand-McNally & Company, 1963, pp. 9 & 12.

telephone directories.

The population consisted of the following:

	<u>SIC Code</u>	<u>Type of Construction</u>
Construction	151	General Building Contractors
	162	Heavy Construction Except Highway and Street Construction
	175	Carpentering
	656	Operative Builders
Distribution	509	Miscellaneous Wholesalers of Lumber and Construction Materials
	521	Lumber Yards and Building Materials Dealers
	241	Logging Camps and Logging Contractors
	242	Sawmills and Planing Mills
Home Manufacturers	243	Prefabricated Structure Manufacturers
Mobile Home Manufacturers	379	Mobile Dwelling Manufacturers
Manufacturers	243	Millwork Plants
	244	Wooden Containers
	249	Miscellaneous Wood Products
	251	Household Furniture
	252	Office Furniture
	253	Public Building & Related Furniture
	254	Partitions, Shelving, Lockers and Fixtures
	259	Miscellaneous Furniture and Fixtures
	371	Motor Vehicles and Equipment
	373	Ships and Boat Building and Repairing
	379	Miscellaneous Transportation Equipment

The populations were determined by types of operations conducted by the firms according to Standard Industrial Classification (SIC) codes. The firms were first contacted by means of a mail questionnaire requesting data on the specific kind of operation in which the firm was engaged, the type of product manufactured or the type of service rendered, the extent of business activity in 1966, the amounts of plywood used, where plywood

was obtained and for what purposes the plywood was used.

With respect to the construction population, an additional procedure was used. The first step was to contact the entire population by means of a classification or sorting questionnaire to determine specifically the type of business in which each was engaged. Each was asked whether they were:

- (1) Principal contractor of single family homes
- (2) Subcontractor of single family homes
- (3) Principal contractor of apartment and nonresidential construction
- (4) Subcontractor of apartment and nonresidential construction

On the basis of the reply to this questionnaire (later referred to as the "sorting questionnaire") the construction population was divided into the four subgroups and questionnaires designed specifically for the particular type of work done by each contractor were mailed to them. These latter questionnaires requested detailed information concerning the amounts of plywood used, the extent of construction activity by the firms and specific applications for the plywood.

Since the response to detailed questionnaires was relatively low from the construction population and only a small proportion of the plywood shipped into the area was accounted for, a second method for obtaining information concerning plywood use was tried through personal contact. This was done through random sampling of the nonrespondent firms and hand delivering questionnaires to them. At the time of delivery the contacted firm was asked to either: (1) fill out the questionnaire and have it picked up several days later, or (2) provide the information at the present time. Most firms preferred the latter alternative.

As previously mentioned, the mail return from detailed construction questionnaires was relatively low. In order to test the reliability of

mailed questionnaire data, a personal interview was conducted for 149 nonrespondent firms. The dual purpose for these interviews was to obtain the information asked for in the mailed questionnaires and to determine why firms had not responded.

During the summer of 1968 enumerators interviewed a selected sample of the building and construction firms who had responded to earlier mailed and personal interview questionnaires. These firms were asked to respond to detailed questions regarding their reasons for selecting the building materials. Firms interviewed for this purpose revealed that they used plywood in all end uses except exterior siding and finished floors.

For each application, i. e., roof sheathing, wall sheathing, soffits, etc., information was obtained regarding the one who made the decision for materials selected, others entering into the decision making process, the material most often used for each application, and the first, second, and third primary reasons for using the material. Enumerators provided the respondents with the following list of reasons from which the respondents could choose to explain their choice of materials:

- a. Prices paid for materials
- b. Cost of installation
- c. Reputation of manufacturer
- d. Guarantees and warranties
- e. Credit and financing
- f. Manufacturer and distributor assistance (on-site delivery, precutting, packaging, etc.)
- g. Ease of procurement
- h. Building code, FHA, VA, etc. requirements
- i. Ease and durability of finishing
- k. Customer preference (fashions, fads, etc.)
- l. Architectural appearance
- m. Other (specify) _____

More detailed questions were asked regarding each of the reasons selected.

These are presented in Appendix I .

Another method tested as a means of obtaining qualitative information about plywood as a competitive building material was the use of in depth interviews of panel groups. The methodology for this approach was to assemble representatives from different construction and building firms [preferably 4-6 people] for the purpose of informally discussing industry problems and evaluating the merits of alternative building materials for different end uses. Refreshments were provided to further develop a relaxed atmosphere. A tape recording was made of the session so that the panel moderator could be free of note taking. This method is sometimes called the "snowball interview" since members of the panel respond to what has been said by other members. In this way a large amount of information can be collected in a fairly short time.

ANALYSIS OF DATA COLLECTED IN STUDY PHASES ONE AND TWO RESPONSE TO MAILED QUESTIONNAIRES

There were 957 firms in the construction population. Each of these firms was mailed the "sorting" questionnaire and 53 were returned because of insufficient and faulty addresses or changes of status of the firms under consideration. After reducing the population size by the number of questionnaires which did not reach their intended recipients, the 601 returned questionnaires represented a 67 percent response (Table 1). Based on these "sorting" questionnaires, respondents were further classified as plywood users and nonusers. There were 396 firms which reported using plywood during the study period, and these became the population for this industry segment which were contacted with detailed mail questionnaires according to the type of construction work done by the firm (Table 2).

Table 1. Beginning Populations, Sizes, and Returns from Each Population, Arizona, 1966.

	Size of Population	No. of Respondents	Return for Misc. Reason	% Return ¹
Construction	957	601	53	67
Distribution	336	90	22	29
Manufacturers	92	25	7	29
Home Manufacturers	5	0	1	0
Mobile Home Manufacturers	7	3	1	50
Total	1,397	719	84	54.76

¹ Percentage return is figured on the basis that true population size is equal to the original population less those questionnaires returned with faulty addresses and for other reasons.

A total of 569 questionnaires were sent to the subgroups of the construction population. This exceeded the number of firms in the construction population who responded to the "sorting" questionnaire and reported plywood use. The reason for the difference was that some firms indicated they had engaged in both principal contracting projects and subcontracting projects. More than one type of questionnaire was sent to these firms. These firms were then considered in the analysis as both a principal contractor and as a subcontractor of the specific type of construction.

The percentage return of the detailed mail questionnaire ranged from a low of 18 percent by principal contractors of apartment and nonresidential construction to 33 percent from subcontractors of the same type of construction (Table 2).

No information from Home Manufacturers was obtained, while Mobile Home Manufacturers showed a return of 50 percent. None of these firms reported plywood use (Table 2).

Table 2. Breakdown of the Construction Population on the Basis of the Classification Questionnaire, Arizona, 1966.

Numbers and percents	Classification Questionnaire	Principal NonResid.	Sub Non-Residential	Principal Single Home	Sub-Single Home	Row Totals of Last 4 Columns
Number Sent	957	237	42	251	39	569
Number Returned	601	43	14	63	10	130
Percent Returned	(62)	(18)	(33)	(25)	(26)	(23)
Number Using Plywood	396 (66)	25 (58)	8 (57)	45 (71)	3 (30)	81 (62)
Number Not Using Plywood	205 (34)	18 (42)	6 (43)	18 (29)	7 (70)	49 (38)
Total	601 (100)	43 (100)	14 (100)	63 (100)	10 (100)	130 (100)

(Numbers in parenthesis are percentages of column totals.)

Table 2a. Returns from Personal Contacts of Contractors, Arizona.

	Principal Non-Res.	Sub Non-Res.	Principal Single Family	Sub Single Family	Total
No. Plywood Users ¹	19 (13.17)	3 (5)	28 (46.67)	10 (16.67)	60 (100)
Nonplywood Users	n.a.	n.a.	n.a.	n.a.	33
Usuable Returns	n.a.	n.a.	n.a.	n.a.	56
Total No.	19	3	28	10	149

¹Percentages in parenthesis are calculated on row totals.

REASONS FOR NONRESPONSE

Reasons for the nonresponse to the mail questionnaire were diverse. Many builders who used small amounts of plywood or did only a few small construction jobs during 1966 felt that any information they could provide would not be of use to the study. Some builders felt that in order to complete the questionnaires satisfactorily it would require hours of record searching on their part. Some builders said that the questions were not asked in the manner in which they kept their records. For example, the questionnaire for principal contractors of apartment and nonresidential construction asked for a listing of construction projects such as churches, schools, offices, etc., the number of each, the square feet of floor area and dollar value of construction projects. Builders could easily enough provide these data, but when they were asked for amounts of plywood usage in the projects it was more difficult. Most said they had no idea of the total amount of plywood used and to determine it they had to search records and sometimes blue prints to determine what amounts of plywood were used in each of the structures, and the purposes for which it was used. The questionnaire asked for the total amount of plywood and then for a percentage breakdown of that amount for the various structures built by the firms. In order to obtain the total amount that was used the builder had to add up the amounts in square feet that he used for each project and then break the total down again by percentages. To many this appeared to be a formidable task.

Other builders referred to the plywood they used as X number of sheets because invoices of their purchases record it as such. So in order to obtain the number of square feet calculations were involved for the builder. Various other reasons were given for nonresponse such as a

feeling that questionnaires were too long or that they didn't have time. Some could see no value in the study as far as their own operation was concerned.

The technique of supplementing the mail returns with personal contacts made it possible, so far as the construction population was concerned, to present two sets of similar data from the same population. Thus, it was possible to make comparisons between and evaluations of the two techniques.

FINDINGS

There were 60 firms out of the total number of contacts made which used plywood and were willing to complete the questionnaire (Table 2a). Of the total number of contacts made, 56 constituted unusable returns due to such reasons as no longer in this type of business and firms which refused to cooperate in providing data.

Of the total 5,333,864 sq. ft. of softwood plywood used by firms reporting on the mail questionnaire, nearly 50 percent was used by principal contractors of single family homes (Table 3a). By contrast, subcontractors of the same type of construction accounted for only a little over 1 percent of the total softwood plywood. This would seem to indicate that of the reporting firms, most principal contractors did not employ subcontractors for jobs which utilized softwood plywood. It could also mean that work done by subcontractors is of the nature that principal contractors supplied the materials to be used on the job.

The principal and subcontractors of apartment and nonresidential construction that responded by mail used nearly equal amounts of softwood plywood, 861,445 sq. ft. and 717,802 sq. ft. respectively. Manufacturers used approximately 20 percent of the reported softwood plywood, 1,063,813

Table 3. Amounts and Percents of Plywood Used by
Major User Groups, Arizona, 1966.
(3/8" Basis for Softwood)

a) Mail Questionnaire

Plywood Users	Softwood		Hardwood	
	Amt. in Sq. ft.	% of Total	Amt. in Sq. ft.	% of Total
Principal Non-Resident	861,445	16.15	26,700	2.5
Sub Non-Resident	717,802	13.46	141,200	13.22
Principal Single Home	2,629,589	49.3	212,880	19.93
Sub Single Home	61,215	1.15	2,300	.22
Manufacturers	1,063,813	19.94	685,056	64.12
Totals	5,333,864	100%	1,068,136	100%

b) Personal Interview

Principal Non-Resident	2,048,587	28.2	201,778	57.51
Sub Non-Resident	12,267	1.69	6,400	.18
Principal Single Home	4,404,772	60.7	111,820	31.87
Sub Single Home	787,290	10.85	30,840	8.79
Totals	7,252,916	100%	350,838	100%

c) Combined Data

Principal Non-Resident	2,910,032	23.16	228,478	16.1
Sub Non-Resident	730,069	5.8	147,600	10.4
Principal Single Home	7,034,361	55.89	324,700	22.88
Sub Single Home	848,505	6.74	33,140	2.34
Manufacturers	1,063,813	8.45	685,056	48.28
Totals	12,586,780	100%	1,418,974	100%

sq. ft. and 64 percent of the hardwood (Table 3a).

A larger amount of the total softwood plywood used by contractors was accounted for by the personal contact method than by the mail questionnaire. Over 7 million sq. ft. were used by the four types of contractors of which about 6.5 million sq. ft. were used by principal contractors (Table 3b). Single family home construction used about 60 percent of the softwood and 32 percent of the hardwood. Principal contractors of apartment and nonresidential construction used the largest amount of hardwood plywood.

The distinction noted previously concerning the use of plywood by subcontractors in relation to principal contractors of the same type of construction appeared to be reversed in the personal interview sample. It appeared that principal contractors of single family homes did employ some subcontractors who purchased the plywood they used. Subcontractors of nonresidential construction in this case used very little plywood.

PRINCIPAL CONTRACTORS OF APARTMENT AND NONRESIDENTIAL CONSTRUCTION

Types of Construction

Principal contractors of apartment and nonresidential construction engaged in varied kinds of projects ranging from schools and offices to bridges and highways (Table 4).

Each of the categories in Table 4 has been aggregated to contain several types of projects. For example, educational facilities includes such projects as the construction of new school buildings, remodeling and classroom additions to existing structures, and library construction. The private and government office classification is self-explanatory. Commercial buildings includes such structures as stores and shops, and other places of business activity. The item entitled "other" includes all types of

Table 4. Types, Value, and Floor Area of Construction done
by Principal Contractors of Apartment and Non Residential
Construction, Arizona, 1966.

a) Mail Questionnaire

Non Residential Buildings	Total Floor Area (sq. ft.)	Floor Area/Bldr. (sq. ft.)	No. of Buildings	Value of Construct. (000)	Value /Bldr. (000)	Value/Sq.ft. Floor Area (\$)
Educational Facilities	125,800	5,032	20	2,037.	81.5	16
Private & Government Offices	335,000	13,400	17	1,653.	66.1	5
Commercial Buildings	108,480	4,339	28	1,774.	70.9	16
Warehouses	63,000	2,520	4	510.	20.4	8
Other	91,450	3,658	8	1,346.	53.9	15
Totals	723,730	28,948	77	7,320.	392.8	10

b) Personal Interview

Educational Facilities	173,000	9,105	9	2,701.	142.1	16
Private & Government Offices	2,433,533	128,080	12	36,879.	1,941.	15
Commercial Buildings	849,475	44,709	107	8,007.	421.4	9
Warehouses	32,000	1,684	5	430.	22.6	13
Other	38,080	2,004	5	600.	31.6	16
Totals	3,526,088	185,583	138	48,617.	2,558.8	15

c) Combined

Educational Facilities	298,800	6,791	29	4,738.	107.7	15.85
Private & Government Offices	2,768,533	62,921	29	38,532.	875.7	13.91
Commercial Buildings	957,955	21,772	135	9,781.	222.3	10.20
Warehouses	95,000	2,159	9	940.	21.6	9.89
Other	129,530	2,944	13	1,946.	44.6	15.02
Totals	4,249,818	96,587	215	55,937.	1,271.3	13.16

nonresidential buildings that are not included in the first four items.

Total square feet of floor area of nonresidential construction reported in mail questionnaires was 723,730 sq. ft. contrasted to 3.5 million sq. ft. reported in personal interviews. It is obvious that the personal contact method elicited greater response from large plywood users than did the mail questionnaires. Commercial buildings were the most important for each of the samples with respect to the number of structures built by each. However, private and government office buildings accounted for the largest share of total square feet of construction.

The value of construction for all firms combined shows that private and government office buildings again accounted for the largest percent of the total value of construction. However, this does not hold true when looking at the two individual samples. Educational facilities were most important to the mail questionnaire sample. The firms interviewed also accounted for the largest volume of activity for nonbuilding construction (Table 5).

Table 5. Types of Nonbuilding Construction Conducted by Principal Contractors in Arizona, 1966.

	Total Dollar Value (000)	Value /Bldr. (000)	Total \$Value (000)	Value /Bldr. (000)	Total \$Value (000)	Value /Bldr. (000)
Bridges						
Highways,						
Research and						
Development						
Test Facilities, etc.	7,805	1,561	11,555	3,852	19,360	2,420

Plywood Use by Different Size Firms

The size classes were determined on the basis of the dollar value of construction reported. The mail respondents consisted of eight firms which engaged in less than \$100,000 of construction activity during 1966,

ten firms were in the \$100,000 to \$1 million size class, and seven firms engaged in construction activity exceeding \$1 million (Table 6). Over 54 percent of the plywood reported was used by the seven largest firms which comprised 28 percent of the firms sampled.

The firms interviewed used over 2 million sq. ft. of plywood which went primarily to the largest size class of firms. This class represented 36 percent of the firms in the group but they used over 65 percent of the plywood. This sample had a smaller percent of its firms in the smallest size class than did the mail sample.

Sources of Plywood Supply

Those firms responding to the mail questionnaire purchased about 83 percent of their plywood from wholesale and retail dealers inside the study area (Table 7a), while firms in the smallest size class purchased about 72 percent of their plywood requirements from dealers located in the study area. Nearly one-third of the plywood used by the middle-sized firms came from dealers outside the area. The remainder came from either dealers or other sources in the area. The largest firms purchased nearly all of their plywood from dealers in the study area (98 percent).

One important distinction evident in this table is that the largest firms purchased almost all of their plywood from dealers in the study area while the firms in the other size classes purchased at least 25 percent of their plywood from sources other than wholesale or retail dealers. One reason for this may be an advantage with respect to price for the largest firms in quantity purchases of plywood. Another is that in looking at the geographical area under observation, the metropolitan areas of the study area are centralized around Phoenix and Tucson. If it can be

Table 6. Percentage Shares of Total Softwood Plywood Purchased by Size Classes of Principal Contractors of Apartment and Nonresidential Construction, Arizona, 1966.

(a) Mail Questionnaire				
\$ Value of Construction	No. of Contractors	% of Total	Amt. of Ply. in Sq. Ft.	% of Total Use
Less than \$100,000	8	32	32,745	3.8
\$100,000 to \$1 million	10	40	357,700	41.52
Over \$1 million	7	28	471,000	54.68
Total	25	100	861,445	100
(b) Personal Interview				
Less than \$100,000	4	21.05	169,597	8.28
\$100,000 to \$1 million	8	42.11	538,371	26.28
Over \$1 million	7	36.84	1,340,619	65.44
Total	19	100	2,048,587	100
(c) Combined				
Less than \$100,000	12	27.27	202,342	6.95
\$100,000 to \$1 million	18	40.91	896,071	30.79
Over \$1 million	14	31.82	1,811,619	62.25
Total	44	100	2,910,032	100

Table 7. Sources of Softwood Plywood Used by Principal Contractors of Non Residential Construction, Arizona, 1966.

(3/8" Basis)

a) Mail Questionnaire

Sources ¹	Value of Constr. \$100,000		Value of Constr. \$100,000 to \$1 Mill.		Value of Constr. \$1,000,000		Total Amt. from each Source	% of the Total From each Source
	Amt. in Sq.Ft.	% of Total	Amt. in Sq.Ft.	% of Total	Amt. in Sq.Ft.	% of Total		
From Mills:								
In Study Area	None	--	None	--	None	--	None	--
Outside Study Area	None	--	None	--	None	--	None	--
From Wholesale or Retail Dlr.								
In Study Area	23,753	72.54 (3.31)	232,147	64.90 (32.36)	461,533	97.99 (64.33)	717,433	83.23
Outside Study Area	1,284	3.92 (1.09)	106,702	29.83 (90.85)	9,467	2.01 (8.06)	117,453	13.64
Other Sources								
In Study Area	7,708	23.54 (29.02)	18,851	5.27 (70.98)	None	--	26,559	3.08
Outside Study Area	None	--	None	--	None	--	None	--
Total Amount Purchased								
	32,745	100	357,700	100	471,000	100	861,445	100

b) Personal Interview

From Mills:								
In Study Area	None	--	None	--	None	--	None	--
Outside Study Area	9,600	5.66 (100)	None	--	None	--	9,600	.47
From Wholesale or Retail Dlr.								
In Study Area	159,997	94.12 (7.85)	538,371	100 (26.40)	1,340,619	100 (65.75)	2,038,987	99.53
Outside Study Area	None	--	None	--	None	--	None	--
Other Sources								
In Study Area	None	--	None	--	None	--	None	--
Outside Study Area	None	--	None	--	None	--	None	--
Total Amount Purchased	169,597	100	538,371	100	1,340,619	100	2,048,587	100

c) Combined

From Mills:								
In Study Area	None	--	None	--	None	--	None	--
Outside Study Area	9,600	4.74 (100)	None	--	None	--	9,600	.33
From Wholesale or Retail Dlr.								
In Study Area	183,750	90.81 (6.67)	770,518	85.99 (27.95)	1,802,152	99.48 (65.38)	2,756,420	94.71
Outside Study Area	1,284	.63 (1.09)	106,702	11.91 (90.85)	9,467	.52 (8.06)	117,453	4.04
From Other Sources								
In Study Area	7,708	3.81 (29.02)	18,851	2.10 (70.98)	None	--	26,559	.91
Outside Study Area	None	--	None	--	None	--	None	--
Total Amount Purchased	202,342	100	896,071	100	1,811,619	100	2,910,032	100

¹ Percentages in parenthesis are calculated on row totals.

assumed that the largest firms are located in the metropolitan areas, where most construction activity is carried on, then it follows that they would probably seek sources of supply close to their operations. This would leave the periphery of the study area for smaller firms in which case, a convenient source of supply may be located outside of the study area.

All but a small amount of plywood used by builders in the personal interview sample came from dealers in the study area. This finding is consistent with the mailed sample since larger firms on the average responded to the personal interview.

Hardwood plywood was obtained by the responding firms in much the same manner as was softwood. The only difference in the pattern was that only the middle-sized firms responding to the mail questionnaires purchased hardwood from dealers outside the study area (Table 8). Very little hardwood was utilized by firms engaged in apartment and nonresidential construction (Table 9).

The most important finding was that very little hardwood was utilized by the firms under observation. As will be seen later, the average amounts of hardwood used by the builders was very small as was the number of purposes for which it was utilized.

Distribution of Plywood Among the Various Types of Construction

Data in Table 10 show the amounts and percentages of total softwood and hardwood plywood which was consumed in each of the different types of nonresidential construction by the two groups of respondents. Firms responding to mail questionnaires consumed 861,445 sq. ft. of softwood and 20 percent was used in projects included in the "other" nonresidential

Table 8. Sources of Hardwood Plywood Used by Principal Contractors of Non Residential Construction, Arizona, 1966.

a) Mail Questionnaire								
Sources ¹	Constr.	\$100,000	Value of	Value of Constr.	Value of Constr.	Total Amt.	% of	
	Amt. in	% of	\$100,000	Amt. in	Amt. in	From Each	the Total	
	Sq. Ft.	Total	Sq. Ft.	% of	Sq. Ft.	Source	From Each	
			Total	Total	Total		Source	
From Mills								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
From Wholesale or Retail Dlr.								
In Study Area	8,200	100 (36.61)	13,200	75.43 (58.93)	1,000	100 (4.46)	22,400	83.90
Outside Study Area	None	---	4,300	24.57 (100)	None	---	4,300	16.10
Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Total Amt. Purchased	8,200	100	17,500	100	1,000	100	26,700	100
b) Personal Interview								
From Mills								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
From Wholesale or Retail Dlr.								
In Study Area	21,050	100 (10.43)	174,228	100 (86.35)	6,500	100 (3.22)	201,778	100
Outside Study Area	None	---	None	---	None	---	None	---
Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Total Amt. Purchased	21,050	100	174,228	100	6,500	100	201,778	100
c) Combined								
From Mills								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
From Wholesale or Retail Dlr.								
In Study Area	29,250	100 (13.05)	187,428	97.76 (83.61)	7,500	100 (3.35)	224,178	98.12
Outside Study Area	None	---	4,300	2.24 (100)	None	---	4,300	1.88
Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Total Amt. Purchased	29,250	100	191,728	100	7,500	100	228,478	100

Table 9. Percentage Shares of Total Hardwood Plywood Purchased by Size Classes of Principal Contractors, Arizona, 1966.

(a) Mail Questionnaire				
\$ Value of Construction	No. of Contractors	% of Total	Amt. of Ply. in Sq. Ft.	% of Total Use
Less than \$100,000	8	32	8,200	30.71
\$100,000 to \$1 Million	10	40	17,500	65.54
Over \$1 Million	7	28	1,000	3.75
Total	25	100	26,700	100
(b) Personal Interview				
Less than \$100,000	4	21.05	21,050	10.43
\$100,000 to \$1 Million	8	42.11	174,228	86.35
Over \$1 Million	7	36.84	6,500	3.22
Total	19	100	201,778	100
(c) Combined				
Less than \$100,000	12	27.27	29,250	12.80
\$100,000 to \$1 Million	18	40.91	191,728	83.92
Over \$1 Million	14	31.82	7,500	3.28
Total	44	100	228,478	100

building category. The next largest amount went to private and governmental offices, with 18 percent of the total. Considerable amounts were also used in garden apartments and educational facilities. These four categories together accounted for over 70 percent of the softwood plywood reported used by these firms.

A slightly different distribution of plywood among the types of construction occurred for firms that furnished data when personally contacted. Of the 2 million sq. ft. of softwood used almost 40 percent went into commercial buildings. Educational facilities was the second largest user of softwood plywood, accounting for over 16 percent of the total. Firms in both samples used almost the same percentage of their total softwood for bridge and highway construction. The largest share of hardwood went into private and government office buildings (Table 10).

There were obvious differences in type of construction projects for which plywood was used by different size of contractors. The smallest firms of the mail sample used almost all of their softwood plywood for nonresidential buildings and 4 percent in formwork (Table 11a). Middle sized firms also used the largest amount of their softwood for nonresidential buildings but 9 percent of their plywood was used for high-rise and garden apartments. Over 50 percent of the softwood plywood used by the largest firms was accounted for by garden apartments and private and government office buildings. The next largest use of plywood for large firms was bridges and highways representing 20 percent of the total, and educational facilities with about 13 percent of the total. The differences in plywood usage among the firms responding to the mail questionnaire denote that the smallest firms did not build apartments, commercial buildings, warehouses, or highways and bridges while the other two size classes did.

Table 10. Percentages and Amounts of Plywood Used in Different Types of Structures by Principal Contractors of Non Residential and Apartment Construction, Arizona, 1966.

(3/8" Basis for Softwood)

Types of Structures	a) Mail Questionnaire				b) Personal Interview				c) Combined			
	Softwood		Hardwood		Softwood		Hardwood		Softwood		Hardwood	
	Amt. Used Sq. Ft.	% of Total	Amt. Used Sq. Ft.	% of Total	Amt. Used Sq. Ft.	% of Total	Amt. Used Sq. Ft.	% of Total	Amt. Used Sq. Ft.	% of Total	Amt. Used Sq. Ft.	% of Total
High Rise Apartments	17,057	1.98	800	2.3	162,331	7.92	24,950	12.37	179,388	6.16	25,750	11.27
Garden Apartments	144,723	16.80	None	---	None	---	None	---	144,723	4.97	None	---
Non-Residential Bldgs.												
Educational Fac.	137,917	16.01	2,300	8.6	340,987	16.64	None	---	478,904	16.46	2,300	1.00
Private & Gov't. Offices	155,577	18.06	4,600	17.2	247,230	12.07	156,828	77.72	402,807	13.84	161,428	70.65
Commercial Bldgs.	73,309	8.51	8,000	30.	808,947	39.49	20,000	9.91	882,256	30.32	28,000	12.26
Warehouses	53,927	6.26	2,000	7.5	44,811	2.19	None	---	98,738	3.39	2,000	.88
Other	174,529	20.26	9,000	33.7	145,766	7.12	None	---	320,295	11.00	9,000	3.94
Non-Bldg. Construction												
Bridge & Highway	95,620	11.10	None	---	241,042	11.77	None	---	336,662	11.57	None	---
Formwork	2,584	.30	None	---	57,600	2.81	None	---	60,184	2.07	None	---
Other	6,202	.72	None	---	None	---	None	---	6,202	.21	None	---
Total	861,445	100	26,700	100	2,048,714	100	201,778	100	2,910,159	100	228,478	100

Table 11-a. Percents and Amounts of Softwood Plywood
Used in Non Residential and Apartment Construction
by Size Classes of Contractors, Arizona, 1966.
(3/8" Basis)

a) Mail Questionnaire

Type of Structure	Value of Constr. \$100,000		Value of Constr. \$100,000 to \$1 Mill.		Value of Constr. \$1,000,000	
	Total Amt. Sq. Ft.	% of Total	Total Amt. Sq. Ft.	% of Total	Total Amt. Sq. Ft.	% of Total
High-Rise Apts.	None	----	16,848	4.71	None	----
Garden Apts.	None	----	15,238	4.26	132,210	28.07
Non-Resid. Bldgs.						
Educ. Facilities	11,550	35.27	61,882	17.30	62,926	13.36
Priv. & Gov't. Offices	7,708	23.54	23,251	6.50	125,522	26.65
Commercial Buildings	None	----	30,655	8.57	43,285	9.19
Warehouses	None	----	53,369	14.92	None	----
Other	12,204	37.27	152,237	42.56	6,311	1.34
Non-Bldg. Constr.						
Bridge & Highway	None	----	3,219	.90	94,436	20.05
Formwork	1,284	3.92	1,037	.29	None	----
Other	None	----	None	----	6,311	1.34
Totals	32,745	100	357,700	100	471,000	100

Commercial buildings accounted for almost 90 percent of the total softwood plywood (169,597 sq. ft.) used by small firms in the personal interview sample (Table 11b). This was in direct contrast to this size firm in the mail sample. Middle sized firms did not show a distribution of plywood among as many types of construction as did the firms in the mail sample. About 40 percent of the total in this case went into

Table 11-b. Percents and Amounts of Softwood Plywood
Used in Non Residential and Apartment Construction
by Size Classes of Contractors, Arizona, 1966.

(3/8" Basis)

b) Personal Interview

Type of Structure	Value of Constr. \$100,000		Value of Constr. \$100,000 to \$1 Mill.		Value of Constr. \$1,000,000	
	Total Amt. Sq. Ft.	% of Total	Total Amt. Sq. Ft.	% of Total	Total Amt. Sq. Ft.	% of Total
High-Rise Apts.	None	----	72,333	13.43	89,998	6.71
Garden Apts.	None	----	None	----	None	----
Non-Resid. Bldgs.						
Educ. Facilities	None	----	55,400	10.29	285,587	21.30
Priv. & Gov't. Offices	8,000	4.71	69,572	12.92	169,658	12.66
Commercial Buildings	151,997	89.62	213,212	39.59	443,738	33.10
Warehouses	None	---	None	---	44,811	3.34
Other	None		127,982	23.77	17,784	1.33
Non-Bldg. Constr.						
Bridge & Highway	9,600	5.66	None	---	231,442	17.26
Formwork	None	---	None	----	57,600	4.30
Other	None	---	None	---	None	----
Totals	169,597	100	538,499	100	1,340,618	100

commercial buildings with almost 24 percent going to "other" projects. The largest firms of this group showed a distribution of their plywood among nearly all types of construction. In absolute amounts, the large firms used more square feet of plywood for every type of construction than either of the other size classes. Of the total amount used, 33 percent was for commercial buildings, 21 percent was for educational facilities and 17

percent was for bridges and highways.

Table 11-c. Percents and Amounts of Softwood Plywood
Used in Non Residential and Apartment Construction
by Size Classes of Contractors, Arizona, 1966.
(3/8" Basis)

c) Combined

Type of Structure	Value of Constr. \$100,000		Value of Constr. \$100,000 to \$1 Mill.		Value of Constr. \$1,000,000	
	Sq. Ft.	Total Amt. % of Total	Sq. Ft.	Total Amt. % of Total	Sq. Ft.	Total Amt. % of Total
High-Rise Apts.	None	---	89,181	9.95	89,998	4.97
Garden Apts.	None	---	15,238	1.70	132,210	7.30
Non-Resid. Bldgs.						
Educ. Facilities	11,550	5.71	117,282	13.09	348,513	19.24
Priv. & Gov't. Offices	15,708	7.76	92,823	10.36	295,180	16.29
Commercial Buildings	151,997	75.12	243,867	27.21	487,023	26.88
Warehouses	None	---	53,369	5.95	44,811	2.47
Other	12,204	6.03	280,219	31.27	24,095	1.33
Non-Bldg. Constr.						
Bridge & Highway	9,600	4.74	3,219	.36	325,878	17.99
Formwork	1,284	.63	1,037	.12	57,600	3.13
Other	None	---	None	---	6,311	.35
Totals	202,343	100	896,255	100	1,811,619	100

Hardwood plywood distribution among the various types of construction by different size firms is found in Appendix Table II. Due to the small amounts of hardwood reported by the firms, it is difficult to infer much from that data. However, it is evident that middle sized firms of

the mail sample used the largest amount, and that it was used almost exclusively for nonresidential buildings. All of the hardwood used by the rest of the firms was for nonresidential buildings.

Firms of the personal interview sample showed a slight difference in the utilization pattern. All three size classes used hardwood for offices while only the small firms used it for commercial buildings. In addition to that used in offices, the other two classes of firms used hardwood in high-rise apartments.

Specific End Uses for Softwood Plywood

Tables 12a and 13a show the total amounts of softwood plywood used in specific applications for firms responding to the mail questionnaires and for firms which were personally interviewed, respectively. Table 14a contains the combined data for each end use. Averages in the first two tables are based on the number of firms in each respective sample, while averages in the third are based on the total number of firms of both samples combined.

For each of the average amounts, confidence intervals of the population means were calculated with a confidence coefficient of 90 percent. This coefficient indicates that if all possible samples of a given size were drawn from a population and confidence intervals constructed around the population mean, 90 out of 100 of the intervals would contain the mean.¹⁶

In calculating the intervals for each of the specific end uses it was found that variances were very large in most cases, due to the diverse patterns of usage by many of the firms. In some cases the amounts of

¹⁶Li, Jerome C. R., Statistical Inference I., Edward Brothers Inc. Ann Arbor, Michigan, 1964, Chapter 11.

plywood used by firms for a specific end use ranged from zero usage to over one hundred thousand square feet of usage in a size class. In such cases the variances of the sample means become very large and standard errors were larger than the sample means; consequently, when intervals were constructed they became very large, often with the lower confidence limit becoming a negative number. When this happens, implications are that the sample is biased or that it is too small to be a reliable estimate of the true population mean. Another conclusion that can be drawn concerning such intervals is that if they are accurate intervals, the population mean would be some value greater than zero, but not larger than the upper confidence limit, and due to the size of the interval this would be a weak statement. Finally, these sample data represent a true picture of plywood use by the industry. The confidence measures alert the researcher to be cautious about generalizing regarding average values by size firm categories or for different end uses.

Data from mail questionnaires in Table 12 show that contractors in the mail sample used softwood plywood for all of the listed end uses except floor underlayment. The total amount of softwood used by respondents exceeded 800 thousand sq. ft. of which over 51 percent went into roof sheathing applications. The next largest amount (26 percent) was used for concrete formwork. Roof decking accounted for 7.5 percent of the total and the remainder was distributed almost evenly among other applications such as soffits, siding, paneling and wall sheathing.

The confidence intervals for these data showed that only paneling and formwork had intervals in which the lower confidence limits were positive. (Confidence coefficients and intervals for specific application are given in Appendix III.) The population mean of the amount of plywood

Table 12. Amounts, Percentages, and Average Amounts of Softwood Plywood
Used for Specific End Uses by Principal Contractors of Apartment
and Non Residential Construction, Arizona, 1966.

(3/8" Basis)

(Mail Questionnaire)

a) Total for all firms¹

b) Contractor Size-Dollar Value of Construction

Uses	Less than \$100,000			Between \$100,000 and \$1 Million			Over \$1 Million					
	Amt. in Sq. Ft.	% of Total	Amt. Per Builder	Amt. in Sq. Ft.	% of Total	Amt. Per Builder	Amt. in Sq. Ft.	% of Total	Amt. Per Builder	Amt. in Sq. Ft.	% of Total	Amt. Per Builder
Roof Sheathing	443,943	51.54	17,758	16,818	51.4 (3.79)	2,102	171,608	47.9 (38.66)	17,161	255,517	54.3 (57.56)	36,503
Roof Decking	64,596	7.50	2,584	3,680	11.2 (5.70)	460	27,583	7.7 (42.70)	2,758	33,333	7.1 (51.60)	4,762
Wall Sheathing	19,119	2.22	765	2,453	7.5 (12.83)	307	16,666	4.7 (87.17)	1,667	None	---	---
Subflooring	11,250	1.31	450	None	---	---	11,250	3.2 (100)	1,125	None	---	---
Floor Underlayment	None	---	---	None	---	---	None	---	---	None	---	---
Soffits	30,832	3.58	1,233	None	---	---	8,750	2.5 (28.38)	875	22,082	4.7 (71.62)	3,155
Siding	31,056	3.61	1,242	210	.6 (.68)	26	16,125	4.5 (51.92)	1,613	14,721	3.1 (47.40)	2,103
Paneling	28,308	3.29	1,132	7,016	21.4 (24.79)	877	21,292	5.9 (75.22)	2,129	None	---	---
Concrete Formwork	224,115	26.02	8,965	1,868	5.7 (.83)	234	76,900	21.5 (34.31)	7,690	145,347	30.8 (64.85)	20,764
Other	8,225	.96	329	700	2.1 (8.51)	88	7,525	2.1 (91.49)	753	None	---	---
Total	861,445	100	34,458	32,745	100 (3.80)	4,093	357,700	100 (41.52)	35,770	471,000	100 (54.68)	67,286

¹Percentages in parenthesis are calculated from the row totals for all firms for each application.

used for paneling by all firms in the mail questionnaire sample was 1132 \pm 1052 sq. ft. and that for concrete formwork was 8965 \pm 6536 sq. ft. All of the other applications for these firms showed intervals with negative lower confidence limits, the reason probably being the diversity of the amounts of plywood usage by the firms when no distinction was made as to size of the firms.

When an interval was constructed for the mean amount of plywood used by the firms responding to the mail questionnaire, without regard for size of the firms or for amounts utilized in the specific applications, a statistically acceptable interval was found. The interval was 34,458 \pm 12,779 sq. ft. for the population mean or the average amount of plywood used was somewhere between 21 thousand sq. ft. and 47 thousand sq. ft.

Firms in the smallest size class used less than 4 percent of the total softwood plywood reported by all firms while the largest firms used 55 percent (Table 13). Plywood was used by small firms in all applications but underlayment, subflooring and soffits. Over 51 percent of the plywood used by these firms went into roof sheathing. Roof sheathing was also the greatest use for plywood by the other two size classes. The formwork was the second most important application by all size firms.

Firms of the largest size used softwood plywood for only five applications. None was used for wall sheathing, subflooring, floor underlayment, or paneling. These firms used the largest proportion of the total plywood that went into roof sheathing (57 percent), roof decking (51.6 percent), soffits (71.6 percent) and for concrete formwork (about 65 percent).

Middle class firms accounted for the largest percentage of the total plywood going into paneling (75 percent), wall sheathing (87 percent), all of that going for subflooring, about 52 percent of that used for siding and 91 percent of that used for other applications.

Table 13 Amounts, Percentages, and Average Amounts of Softwood Plywood
Used for Specific End Uses by Principal Contractors of Apartment
and Non Residential Construction, Arizona, 1966.
(3/8" Basis)

(Personal Interview)

a) Total for All Firms¹

b) Contractor Size-Dollar Value of Construction

Uses	Less than \$100,000			Between \$100,000 and \$1 Million			Over \$1 Million					
	Amt. in Sq. Ft.	% of Total	Amt. Per Builder	Amt. in Sq. Ft.	% of Total	Amt. Per Builder	Amt. in Sq. Ft.	% of Total	Amt. Per Builder	Amt. in Sq. Ft.	% of Total	Amt. Per Builder
Roof Sheathing	1,407,058	68.68	74,056	114,664	67.61 (7.94)	28,666	309,484	57.49 (22.00)	38,686	982,910	73.31 (69.86)	140,416
Roof Decking	125,000	6.10	6,579	None	---	---	125,000	23.22 (100)	15,625	None	---	---
Wall Sheathing	47,800	2.33	2,515	None	---	---	37,800	7.02 (79.08)	4,725	10,000	.75 (20.92)	1,429
Subflooring	2,200	.11	116	None	---	---	2,200	.41 (100)	275	None	---	---
Floor Underlayment	67,486	3.29	3,552	40,000	23.59 (59.27)	10,000	25,486	4.73 (37.76)	3,186	2,000	.15 (2.96)	286
Soffits	33,334	1.63	1,754	None	---	---	13,334	2.48 (40.00)	1,667	20,000	1.50 (60.00)	2,857
Siding	None	---	---	None	---	---	None	---	---	None	---	---
Paneling	2,667	.13	140	None	---	---	2,667	.50 (100)	333	None	---	---
Concrete Formwork	337,442	16.47	17,760	5,333	3.14 (1.58)	1,333	6,400	1.19 (1.90)	800	325,709	24.29 (96.52)	46,529
Other	25,600	1.25	1,347	9,600	5.66 (37.50)	2,400	16,000	2.97 (62.50)	2,000	None	---	---
Total	2,048,587	100	107,820	169,597	100 (8.28)	42,396	538,371	100 (26.28)	67,296	1,340,619	100 (65.44)	191,517

¹Percentages in parenthesis are calculated from the row totals for all firms for each application.

For plywood used as roof sheathing by middle sized firms the interval for the mean amount of usage by all firms was $17,161 \pm 1646$ sq. ft. and for the larger firms it was $36,503 \pm 8635$ sq. ft. Concrete formwork for the largest firms had a mean interval of $20,764 \pm 19,909$ sq. ft.

Intervals of the means of the total amounts of plywood used by each of the three size classes also were statistically acceptable. The smallest firms showed an interval of 4093 ± 1955 sq. ft.; middle sized firms showed an interval of $35,770 \pm 20,033$ sq. ft. and large firms had an interval of $67,286 \pm 26,336$ sq. ft. These intervals show that an estimation of the mean amounts of plywood used by a firm would increase considerably from one size of firm to the next.

Table 13 contains information pertinent to the specific applications for all firms contacted by personal interview. The total amount of softwood plywood reported used by the firms was 2,048,587 sq. ft. which was distributed among the applications as follows. Over 68 percent went into roof sheathing, concrete formwork accounted for about 16.5 percent of the total amount, roof decking accounted for 6 percent of the total and the remainder was distributed among the other applications with the exception of siding. The average amount of plywood for each builder in the sample, without respect to applications, was 107,820 sq. ft.

Confidence intervals constructed for purposes of estimation of the population means appeared to be most accurate for the mean of the total, for roof sheathing and for roof decking. All other intervals, with a confidence coefficient of 90 percent contained negative lower confidence limits, much as was evident for data from the mail questionnaire. The interval for the population mean of the total amount used per builder (the average total amount used) was $107,820 \pm 38,396$ sq. ft. Roof sheathing

had an interval of 74,056 \pm 43,811 sq. ft. and roof decking had an interval of 6579 \pm 764 sq. ft.

Firms of the smallest size class used 169,597 sq. ft. of plywood of which over 67 percent of this was used in roof sheathing and about 23 percent went for floor underlayment. Middle sized firms used over 500 thousand sq. ft. of softwood plywood for all applications except siding. Roof sheathing was again the largest use accounting for over 57 percent of the total, while roof decking used over 23 percent of the total. The largest firms used over 1.3 million sq. ft. of softwood plywood of which nearly 100 percent went into roof sheathing and concrete formwork.

In general the amount of plywood used in different application did not correspond to firm size as was the case with the mail sample. For example, in floor underlayment the smallest firms used a larger amount of plywood than the larger firms. However, the mail return sample of small firms did not use a larger proportion of the total amount of plywood for any application than larger firms. In this case, conclusions drawn on either sample alone could have been misleading.

Confidence intervals of the population means for each of the specific applications for each size class all had negative lower confidence limits except roof sheathing for both the middle sized and largest firms, floor underlayment for the smallest firms, formwork for the largest firms, and paneling for the middle sized firms.

Intervals for the average of the total amount used by the middle sized and large firms were 67,296 \pm 33,874 sq. ft. and 191,517 \pm 71,552 sq. ft. respectively. It is interesting to note that the interval for the middle sized firms in the personal interview sample was similar to that of the largest firms in the mail sample.

In combining the two samples it can be seen that over 63 percent of the plywood was used for roof sheathing and about 19 percent for concrete formwork (Table 14). Roof decking was the next largest application taking 6.5 percent of the plywood. All of the remaining applications used from about 1 percent to 2 percent of the total plywood each, with the exception of subflooring which took less than 1 percent of the total.

The average amount of plywood used by each builder in all uses was over 66,000 sq. ft. Of this amount $42,068 \pm 20,169$ sq. ft. was used for roof sheathing. Roof sheathing was also the most important use made of plywood by each size class.

Confidence intervals for population means of the amounts used by the three size classes for each application all had negative lower limits with the exception of the intervals for the mean of the totals for the smallest firms and for the middle sized firms.

Statistical Difference Between Mail Questionnaire Returns and Personal Interview Returns

Since one objective of the study was to develop a study method, it is appropriate to discuss the statistical differences between the mail questionnaire method and the personal interview method of data collection. Some differences have been intuitively noted previously. The statistical tests asked if there was a difference in plywood usage patterns between the population from which the mail sample was drawn and the population from which the personal interview sample was drawn, or if the samples were drawn from essentially the same population. The tests are based on the differences between the sample means for plywood usage for a specific application by firms in the mail sample as compared to firms in the personal interview sample. In order that the difference between two means

Table 24. Amounts, Percentages, and Average Amounts of Softwood Plywood
Used for Specific and Used by Principal Contractors of Apartment
and Non Residential Construction, Arizona, 1970.

(Combined)

(3/8" Basis)

a) Total for All Firms¹

b) Contractor Size-Dollar Value of Construction

Uses	Less than \$100,000			Between \$100,000 and \$1 Million			Over \$1 Million					
	Amt. in sq. ft.	% of Total	Amt. Per Builder	Amt. in sq. ft.	% of Total	Amt. Per Builder	Amt. in sq. ft.	% of Total	Amt. Per Builder	Amt. in sq. ft.	% of Total	Amt. Per Builder
Roof Sheathing	1,851,001	63.61	42,068	131,482	64.98 (7.10)	2,988	481,092	53.69 (25.99)	10,934	1,238,427	68.36 (66.91)	28,146
Roof Decking	189,596	6.52	4,309	3,680	1.82 (1.94)	84	152,583	17.03 (80.48)	3,468	33,333	1.84 (17.58)	758
Wall Sheathing	66,919	2.30	1,521	2,453	1.21 (3.67)	56	54,466	6.08 (81.39)	1,238	10,000	.55 (14.94)	227
Sub Flooring	13,450	.46	306	None	---	---	13,450	1.50 (100)	306	None	---	---
Floor Underlayment	67,486	2.32	1,534	40,000	19.77 (59.27)	909	25,486	2.84 (37.76)	579	2,000	.11 (2.96)	46
Soffits	64,166	2.20	1,458	None	---	---	22,084	2.46 (34.42)	502	42,082	2.32 (65.58)	956
Siding	31,056	1.07	706	210	.10 (.68)	5	16,125	1.80 (51.92)	367	14,721	.81 (47.40)	335
Paneling	30,975	1.06	704	7,016	3.47 (22.65)	160	23,959	2.63 (77.35)	545	None	---	---
Concrete Formwork	561,557	19.30	12,763	7,201	3.56 (1.28)	164	83,300	9.30 (14.83)	1,893	471,056	26.00 (83.88)	10,706
Other	33,825	1.16	769	10,300	5.09 (30.45)	234	23,525	2.63 (69.55)	535	None	---	---
Total	2,910,031	100	66,137	202,342	100 (6.95)	4,599	896,070	100 (30.79)	20,365	1,811,619	100 (62.25)	41,173

¹Percentages in parenthesis are calculated on the row totals for all firms for each application.

be significant certain qualifications must be met. For each test, a value of the t distribution is defined by the size of the samples under consideration. When the t value derived from the test exceeds the value from the t distribution by an absolute amount there is a significant difference between the two populations.¹⁷ Results of the tests are presented in Appendix IV.

The test concerning the averages of the total amounts of plywood used by firms in both of the samples showed that there was a significant difference between the two samples and therefore between the populations. In this case, the personal interview sample was shown to be taken from a population of firms which on the average used larger amounts of plywood than did firms in the mail sample. The tests also showed that the average amounts of plywood used by a firm in the personal interview sample for roof sheathing and underlayment were significantly larger than for the corresponding applications for firms in the mail questionnaire sample. However, tests on all of the other applications showed that there was no significant difference between the two samples and populations.

From the results of the tests, it is reasonably safe to say that the two samples were almost identical as denoted by there being no significant differences in their usage of plywood in most of the applications. However, it should be added that the firms of the personal interview sample used larger average amounts of plywood for roof sheathing and floor underlayment than firms in the mail sample, therefore the test on the average of the total amount used without regard for application showed the personal interview sample to be different from the other. It can be assumed that the two are similar in their patterns of usage but that more usage of

¹⁷Li. Op. Cit. Chapter 10.

plywood for roof sheathing and underlayment make the personal interview sample as a whole larger users of plywood.

Specific End Uses for Hardwood Plywood

Specific applications for which hardwood was utilized are seen in Appendix Table V. Due to the small amounts reported the interested reader can refer to this table.

PLYWOOD USED BY SUBCONTRACTORS OF APARTMENT AND NONRESIDENTIAL CONSTRUCTION

Subcontractors of apartment and nonresidential construction were handled in the same manner as principal contractors of the same type of construction. Due to the small size of the samples, it was not appropriate to divide the firms into size classes as was done with principal contractors. Only eight firms of this type replied to the mail questionnaire and only three firms were sampled through personal interviews.

Purposes for which plywood was used by subcontractors of apartment and nonresidential construction can be seen in Table 15. Firms in the mail sample used over 700 thousand sq. ft. of softwood plywood and 141 thousand sq. ft. of hardwood plywood. Of the softwood, over 94 percent was used in construction of new structures. This amounted to 84,809 sq. ft. per subcontractor. The remaining softwood was used in remodeling or repair of existing structures.

The largest share of the hardwood also went to construction work on new structures. Slightly under 70 percent was for this type of work, which averaged 12,250 sq. ft. for each subcontractor and about 30 percent was used for repair or remodeling of existing structures.

Subcontractors in the personal contact sample used considerably smaller amounts of both softwood and hardwood than those of the mail

Table 15. Plywood Used by Sub Contractors in Non
Residential Construction in Arizona, 1966.
(3/8" Basis for Softwood)

a) Mail Questionnaire

Purpose for Which Used	Softwood			Hardwood		
	Amt. in Sq. Ft.	% of Total	Sq.Ft. Per Contractor	Amt. in Sq. Ft.	% of Total	Sq.Ft. Per Contractor
Amount Used for Remodel or Rep. Exist.	39,334	5.47	4,917	43,200	30.59	5,400
Amount Used in New Struc.	678,468	94.52	84,809	98,000	69.41	12,250
Total	717,802	100	89,725	141,200	100	17,650

b) Personal Interview

Amount Used for Remodel or Rep. Exist.	12,267	100	4,089	6,400	100	2,133
Amount Used in New Struc.	None	---	---	None	---	---
Total	12,267	100	4,089	6,400	100	2,133

c) Combined

Amount Used for Remodel or Rep. Exist.	51,601	7.07	4,691	49,600	33.60	4,509
Amount Used in New Struc.	678,468	92.93	61,679	98,000	66.40	8,909
Total	730,069	100	66,370	147,600	100	13,418

sample. These builders used all of their plywood for remodeling or repair of existing structures.

Sources of Plywood Used

All plywood used by these subcontractors came from wholesale or retail dealers (Table 16). About 60 percent of the plywood was obtained from dealers within the study area. All of the hardwood they used came

Table 16. Sources of Plywood Used by Sub Contractors
in Non Residential Construction, Arizona, 1966.
(3/8" Basis for Softwood)

Sources	a) Mail Questionnaire				b) Personal Interview				c) Combined			
	Softwood		Hardwood		Softwood		Hardwood		Softwood		Hardwood	
	Amount	% of	Amount	% of	Amount	% of	Amount	% of	Amount	% of	Amount	% of
	Sq.Ft.	Total	Sq.Ft.	Total	Sq.Ft.	Total	Sq.Ft.	Total	Sq.Ft.	Total	Sq.Ft.	Total
From Mill												
In Study Area	None	---	None	---	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---	None	---	None	---
From Whlse. or Retail Dlrs.												
In Study Area	430,179	59.93	141,200	100	12,267	100	6,400	100	442,446	60.60	147,600	100
Outside Study Area	287,623	40.07	None	---	None	---	None	---	287,623	39.40	None	---
From Other Sources												
In Study Area	None	---	None	---	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---	None	---	None	---
Total	717,802	100	141,200	100	12,267	100	6,400	100	730,069	100	147,600	100

from dealers inside the study area. All of the plywood used by firms in the personal contact sample, both softwood and hardwood, came from dealers within the study area.

Types of Construction for Which Plywood Was Used

Plywood used by subcontractors responding to mail questionnaires was for much the same types of structures as did principal contractors of nonresidential construction (Table 17). Most of the softwood used by these firms was for nonresidential buildings but about 20 percent of it was used for bridge construction, and nearly 15 percent was used in other nonbuilding types of construction. All but a small percent of the hardwood plywood used by these firms was for high-rise apartments.

The 12,267 sq. ft. of softwood plywood used by subcontractors in the personal interview sample was used in part in commercial buildings and the remainder went to other nonresidential buildings.

Specific End Uses for Softwood Plywood

Concrete formwork was the largest application for firms of this type. The next largest application was roof sheathing which accounted for only about 11 percent of the total softwood. Other minor applications were roof decking, wall sheathing and floor underlayment (Table 18). These use patterns indicate that as far as plywood is concerned, concrete jobs were most important to the subcontractors. The average amount of plywood used by each firm without regard to application was 89,725 sq. ft. The confidence interval for the true mean value of plywood usage for concrete formwork was $67,061 \pm 62,534$ sq. ft. (Appendix VI).

All of the softwood plywood used by firms in the personal interview sample was concentrated in "other" applications. The average amount used was 4,089 sq. ft. Confidence intervals for these firms had negative lower limits.

Table 17. Percents and Amounts of Plywood Used for Different Types
of Construction by Sub Contractors of Non Residential
Construction, Arizona, 1966.
(3/8" Basis for Softwood)

Types of Construction	a) Mail Questionnaire				b) Personal Interview				c) Combined			
	Softwood		Hardwood		Softwood		Hardwood		Softwood		Hardwood	
	Amount Sq.Ft.	% of Total	Amount Sq.Ft.	% of Total	Amount Sq.Ft.	% of Total	Amount Sq.Ft.	% of Total	Amount Sq.Ft.	% of Total	Amount Sq.Ft.	% of Total
High-Rise Apts.	35,101	4.89	140,000	99.15	None	---	None	---	35,101	4.81	140,000	94.85
Garden Apts.	None	---	None	---	None	---	None	---	None	---	None	---
Non Residential Buildings												
Govt. Bldgs.	219,217	30.54	1,200	.85	None	---	None	---	219,217	30.03	1,200	.81
Commercial Bldgs.	164,377	22.9	None	---	1,600	13.04	None	---	165,977	22.74	None	---
Hospitals	21,893	3.05	None	---	None	---	None	---	21,893	3.00	None	---
Schools	21,893	3.05	None	---	None	---	None	---	21,893	3.00	None	---
Other	8,757	1.22	None	---	10,667	86.96	6,400	100	19,424	2.66	6,400	4.34
Non-Building Construction												
Bridges	140,761	19.61	None	----	None	----	None	---	140,761	19.83	None	---
Other	105,732	14.73	None	----	None	----	None	---	105,732	14.48	None	---
Total	718,802	100	141,200	100	12,267	100	6,400	100	729,998	100	147,600	100

Table 18. Specific End Uses for Softwood Plywood in Apartment
and Non Residential Construction by Sub
Contractors, Arizona, 1966.
(3/8" Basis)

End Uses	a) Mail Questionnaire			b) Personal Interview			c) Combined		
	Total Amt. Sq. Ft.	% of Total	Sq.Ft. Per Sub	Total Amt. Sq. Ft.	% of Total	Sq.Ft. Per Sub	Total Amt. Sq. Ft.	% of Total	Sq.Ft. Per Sub
Roof Sheathing	83,331	11.61	10,416	None	---	---	83,331	11.41	7,576
Roof Decking	6,667	.93	833	None	---	---	6,667	.91	606
Wall Sheathing	31,250	4.35	3,906	None	---	---	31,250	4.28	2,841
Subflooring	None	---	---	None	---	---	None	---	---
Floor Underlayment	25,000	3.48	3,125	None	---	---	25,000	3.43	2,273
Soffits	None	---	---	None	---	---	None	---	---
Siding	None	---	---	None	---	---	None	---	---
Paneling	None	---	---	None	---	---	None	---	---
Concrete Formwork	536,489	74.74	67,061	None	---	---	536,489	73.48	48,772
Other	35,066	4.89	4,383	12,267	100	4,089	47,333	6.48	4,303
Total	717,802	100	89,725	12,267	100	4,089	730,070	100	66,370

Specific End Uses for Hardwood Plywood

The amount of this type of plywood reported is very small. Of the total amount of hardwood plywood used by subcontractors in the mail sample, 140,000 square feet were used for cabinet work while average amount for this use was 7,500 sq. ft., (Appendix Table VII); mahogany, birch and ash were the most important species. Firms in the personal interview sample used all 6,400 sq. ft. of their hardwood for wall paneling. Walnut was the important species.

Significance of the Difference Between Mail Questionnaire Returns and Personal Interviews Returns

Statistical tests relating the two samples of subcontractors showed that there was a significant difference between the two in some cases. When the difference was tested for plywood usage in roof sheathing, floor underlayment and concrete formwork, it was found that the mean value for usage of plywood in these applications was greater for firms of the mail sample. However, in roof decking, wall sheathing and "other" applications there were no significant differences with respect to means. Also when all the plywood was aggregated, the test of the difference between the mean values of usage for the two samples was not significant. Therefore it can be concluded that as far as total usage of plywood was concerned there was no difference in the two samples. It is best to remember that the sample sizes were small. When considering the usage for the specific applications there were differences between the samples (Appendix IV).

CONSTRUCTION AND PLYWOOD USE BY PRINCIPAL CONTRACTORS OF SINGLE FAMILY HOMES

There were 45 principal contractors that reported construction activity and plywood use during 1966 for single family homes by means of

the mail questionnaire. These firms reported using 2,629,590 sq. ft. of softwood plywood and 212,880 sq. ft. of hardwood plywood. There were 28 builders of this type included in the personal interview sample and they used 4,404,772 sq. ft. of softwood plywood and 111,820 sq. ft. of hardwood plywood.

NUMBER OF HOUSES BUILT BY PRICE CLASS

There were 851 houses built by firms responding to the mailing questionnaires (Table 19). About 30 percent of these houses were in the lower price class of \$15,000 or less, almost 25 percent of the houses were in the \$15,000 to \$19,999 price class and less than 2 percent of the homes were accounted for in the \$30,000 to \$34,999 price class. Average floor areas of the houses built ranged from 1166sq. ft. for houses in the lowest price class to 2988 sq. ft. for houses in the highest price class.

Firms in the personal interview sample, although fewer in number, built more houses than those in the mail sample (Table 19). These firms built 1665 houses with over 35 percent of them in the lowest price class and 20 percent in the \$15,000 to \$19,999 price class. The average floor area of houses built by these firms ranged from 1217 sq. ft. to 2834 sq. ft. These averages were larger for the houses in the lowest price class and less for houses in the highest price class than was evident for firms in the mail sample.

TYPES OF HOUSES BUILT

The most common type of houses built in Arizona during 1966 was solid masonry construction for firms in the mail sample and mixed masonry and wood for firms in the personal interview sample (Table 20). Wood frame construction was of minor importance in Arizona. The type of frame

Table 19. Number of Houses Built by Principal Contractors
by Price Class, Arizona, 1966.

Price Class (Selling Price) ¹	a) Mail Questionnaire			b) Personal Interview			c) Combined		
	No. of Houses	Average Floor Area (Sq. Ft.)	Number Houses /Bldr.	No. of Houses	Average Floor Area (Sq. Ft.)	Number Houses /Bldr.	No. of Houses	Average Floor Area (Sq. Ft.)	Number Houses /Bldr.
Under \$15,000	256 (30)	1166	6	597 (35.86)	1217	21	853 (33.90)	1202	12
\$15,000 to \$19,999	212 (24.91)	1536	5	339 (20.36)	1578	12	551 (21.3)	1562	8
\$20,000 to \$24,999	124 (14.57)	1832	3	255 (15.32)	1932	9	379 (15.10)	1899	5
\$25,000 to \$29,999	168 (19.74)	2167	4	256 (15.38)	2037	9	424 (16.8)	2089	6
\$30,000 to \$34,999	15 (1.76)	2383	.3	172 (10.33)	2323	6	187 (7.5)	2328	3
\$35,000 and Over	76 (8.93)	2988	2	46 (2.76)	2834	2	122 (4.9)	2930	2
Total No. Houses	851 (100)			1665 (100)			2516 (100)		

¹The number in parenthesis denotes the percent of houses in each price class.

construction is an item that is strongly influenced by climate. In an area such as Arizona, builders feel that as little wood as possible should be exposed to the weather since the extreme heat and the sun rays make it very difficult to obtain a lasting finish on exposed wood.

Table 20. Types of Houses Built by Principal Contractors, Arizona, 1966.

Type ¹	a)Mail Questionnaire		b)Personal Interview		c)Combined	
	Number Houses	Number /Bldr.	Number Houses	Number /Bldr.	Number Houses	Number /Bldr.
Solid Masonry Constr.	792 (93.06)	18	729 (43.78)	26	1521 (60.45)	21
Wood Frame Constr.	34 (3.99)	1	116 (6.96)	4	150 (5.96)	2
Mixed Masonry and Wood Construction	25 (2.94)	.5	820 (49.24)	29	845 (33.59)	12
Total Number Houses	851 (100)	19	1665 (100)	60	2516 (100)	35

¹The number in parenthesis denotes the percent of the houses in each group.

TEST OF SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE TWO SAMPLES WITH RESPECT TO TYPES OF HOUSES BUILT

Tests of significance of the difference between the two samples on the basis of the types of houses built by firms of each sample showed that there was a difference in the mean total number of houses built. The test indicated that the mean number of houses built by the population from which the personal interview sample was drawn was larger than the mean for firms of the mail population. However, the tests showed that the mean number of houses built according to type of house were not significantly different between the two populations.

From this it can be concluded that the populations were similar

with respect to the types of houses built by each, but they were different with respect to the total number of houses built. Thus a typical firm in the personal interview population built more houses than a counterpart firm in the mail population but these houses were distributed by type pretty much as were the houses built by a firm in the mail population (Appendix Table IV).

CONSTRUCTION CHARACTERISTICS OF HOUSES

Construction characteristics refer to the number of stories or levels of a house. Table 21 denotes that the largest share (97 percent) of houses reported by firms in the two samples were one story structures. The average number of single story houses built by firms in the mail sample was 19 while the average for firms in the personal interview sample was 58.

Confidence intervals were constructed only for single story structures. The interval for the true mean number of one story structures built by firms in the mail population was 19 ± 7 houses. That for the personal interview population was 58 ± 48 houses.

VOLUMES AND SOURCES OF SOFTWOOD PLYWOOD USED

For purposes of the following analysis, the firms of each sample were divided into three classes on the basis of their construction activity during 1966. The three classes were small firms which built from one to ten houses during 1966, the middle sized firms which built from eleven to fifty houses and large firms which built over fifty houses.

The mail sample which contained 45 firms had 26 builders in the smallest size class, 15 in the class building from 11 to 50 houses and 4 builders in the largest class (Table 22). The total amount of softwood

Table 21. Construction Characteristics of Houses Built
by Principal Contractors, Arizona, 1966.

Type of Structure	a) Mail Questionnaire			b) Personal Interview			c) Combined		
	Number Houses	Number /Bldr.	% of Total Houses	Number Houses	Number /Bldr.	% of Total Houses	Number Houses	Number /Bldr.	% of Total Houses
1 Story Structures	832	19	97.77	1624	58	97.53	2456	34	97.62
1½ or 2 Story Structures	12	1	1.40	29	1	1.74	41	1	1.63
Split Level Structures	2	1	.24	1	1	.06	3	1	.12
Other	5	1	.59	11	1	.66	16	1	.64
Total Houses	851		100	1665		100	2516		100

Table 22. Percentage Shares of Total Softwood Plywood Purchased
by Size Classes of Principal Contractors, Arizona, 1966.
(3/8" Basis)

a) Mail Questionnaire						
Contractors Building:	No. of Contr.	% of Total	Amt. of Plywood Sq. Ft.	% of Total	No. of Houses	Plywood/ House
1 to 10 Homes	26	57.78	372,292	14.16	84	3242
11 to 50 Homes	15	33.33	968,718	36.84	397	2440
Over 50 Homes	4	8.88	1,288,580	49.00	370	3483
Totals	45	100	2,629,590	100	851	3090
b) Personal Interview						
1 to 10 Homes	14	50.00	372,974	8.47	62	6016
11 to 50 Homes	8	28.57	827,968	18.8	180	4600
Over 50 Homes	6	21.43	3,203,870	72.74	1423	2252
Totals	28	100	4,404,772	100	1665	2646
c) Combined						
1 to 10 Homes	40	54.79	745,265	10.60	146	5105
11 to 50 Homes	23	31.51	1,796,686	25.54	577	3114
Over 50 Homes	10	13.70	4,492,410	63.86	1793	2506
Totals	73	100	7,034,361	100	2516	2796

plywood used by firms in the mail sample was 2,629,590 sq. ft. About 15 percent of this was used by the smallest firms, which represented about 58 percent of the total number of firms in the sample. Nearly 37 percent of the plywood was used by middle sized firms who were one-third of the total firms and the largest firms, which were less than 9 percent of the total number of respondents used 49 percent of the softwood plywood.

There were 28 firms in the personal interview sample and they used

4,404,772 sq. ft. of softwood plywood during 1966 (Table 22). Fifth percent of these firms built 10 or fewer houses each and used less than 9 percent of the total softwood plywood. The group of middle sized firms were about 29 percent of the total number and they used about 19 percent of plywood. Over 72 percent of the total softwood plywood was used by the large firms but they represented only 21 percent of the total number of firms interviewed.

The average amount of softwood used per house built by the two smaller size classes of firms was considerably larger than that used by the largest firms. For small firms the average was 6,016 sq. ft. which indicates that houses built by these smaller firms may have been extremely large custom built houses or they contained plywood in many different applications. The average amount used when all firms were combined was 2,646 sq. ft. which was less than for firms in the mail questionnaire sample.

The average amount of plywood used in the houses built by all reporting firms ranged from 2,506 sq. ft. for houses built by large contractors to over 5,100 sq. ft. by the other two size classes of builders. The average for houses built by all sizes of firms was 2,796 sq. ft.

Sources from which the firms obtained softwood plywood are shown in Table 23. All of the plywood purchased by firms in both of the samples came from dealers located within the study area, with the exception of 189,225 sq. ft. which came from dealers outside the study area.

VOLUMES AND SOURCES OF HARDWOOD PLYWOOD USED

Firms in the mail sample used 212,880 sq. ft. of hardwood plywood, of which 36 percent was purchased by the firms in the smallest size class

Table 23. Volumes and Sources of Softwood Plywood Purchased by Principal Contractors of Single Family Homes, by Size Classes, Arizona, 1966.
(3/8" Basis)

a) Mail Questionnaire								
Sources ¹	Contr. Bldg.		Contr. Bldg.		Contr.		Total Amt. From Each Source	% of the Total From Each Source
	From 1 to 10 Homes	% of	From 11 to 50 Homes	% of	Bldg. Over 50 Homes	% of		
	Amt. in Sq. Ft.	Total	Amt. in Sq. Ft.	Total	Amt. in Sq. Ft.	Total		
From Mills:								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
From Wholesale or Retail Dlr.								
In Study Area	183,066	49.17 (7.50)	968,718	100 (39.74)	1,288,580	100 (52.80)	2,440,364	92.80
Outside Study Area	189,225	50.83 (100)	None	---	None	---	189,225	7.20
Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Total Amount Purchased								
	372,292	100	968,718	100	1,288,580	100	2,629,590	100
b) Personal Interview								
From Mills:								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
From Wholesale or Retail Dlr.								
In Study Area	372,974	100 (8.47)	827,968	100 (18.8)	3,203,830	100 (72.74)	4,404,772	100
Outside Study Area	None	---	None	---	None	---	None	---
Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Total Amount Purchased								
	372,974	100	827,968	100	3,203,830	100	4,404,772	100
c) Combined								
From Mills:								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
From Wholesale Or Retail Dlr.								
In Study Area	556,040	74.61 (8.12)	1,796,686	100 (26.25)	4,492,410	100 (65.63)	6,845,136	97.31
Outside Study Area	189,225	25.39 (100)	None	---	None	---	189,225	2.69
Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Total Amount Purchased								
	745,265	100	1,796,686	100	4,492,410	100	7,034,361	100

¹ Percentages in parenthesis are calculated on row totals.

(Appendix Table VIII). About 49 percent of the total hardwood was purchased by the middle one-third of the firms and slightly over 15 percent of it was purchased by the large firms.

Less than 4 percent of the hardwood was purchased by the smallest 50 percent of the firms in the personal interview sample. The middle sized firms purchased 70 percent of the hardwood and the remainder was purchased by firms in the largest size class. The sources of hardwood plywood for these builders were almost identical to the sources for softwood plywood.

SPECIFIC APPLICATIONS OF SOFTWOOD PLYWOOD

Of the total softwood used by firms of the mail sample, almost 88 percent was used for roof sheathing (Table 24). This amounted to 2.3 million sq. ft. of plywood, of which nearly 10 percent was used by firms in the small size class, 37.5 percent was used by middle sized firms and 52.5 percent was used by the large firms. Roof sheathing represented 62 percent of the plywood usage for the small firms, 89 percent of the plywood usage for middle sized firms and 94 percent of the plywood usage for the largest firms.

Small firms used the largest amounts of plywood for subflooring, underlayment and finish flooring. Middle sized firms used the largest amount of softwood plywood for soffits. Firms in the largest size class used the largest amounts of softwood plywood for roof sheathing and wall sheathing.

The interval for the average usage of plywood by small firms, without consideration of applications, was $14,319 \pm 2,795$ sq. ft. (Appendix IX). Intervals for mean values of usage by middle sized firms contained negative lower limits in the case of subflooring, underlayment and soffits. The interval for roof sheathing was $57,754 \pm 15,180$

Table 24. Amounts of Softwood Plywood Used in Various End Uses by Principal Contractors of Single Family Homes (by Contractor Size), Arizona, 1966.
(3/8" Basis)

a) Mail Questionnaire								
Uses ¹	Contr. Bldg. From 1 to 10 Homes		Contr. Bldg. From 11 to 50 Homes		Contr. Bldg. Over 50 Homes		Total Amt. of Plywood in Each End Use	% of Total Ply. Used in Each End Use
	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total		
Subflooring	68,864	18.50 (80.73)	13,434	1.39 (15.75)	3,000	.23 (3.52)	85,298	3.24
Underlayment	39,983	10.74 (74.85)	13,434	1.39 (25.15)	None	---	53,417	2.03
Finish Flooring	14,333	3.85 (100)	None	---	None	---	14,333	.55
Roof Sheathing	230,708	61.97 (9.98)	866,308	89.43 (37.49)	1,213,556	94.18 (52.48)	2,310,572	87.87
Wall Sheathing	12,954	3.48 (9.90)	48,855	5.04 (37.34)	69,024	5.36 (52.76)	130,833	4.98
Soffits	5,450	1.46 (15.51)	26,687	2.76 (75.95)	3,000	.23 (8.54)	35,137	1.34
Totals	372,292	100	968,718	100	1,288,580	100	2,629,590	100
b) Personal Interview								
Subflooring	21,175	5.68 (100)	None	---	None	---	21,175	.48
Underlayment	20,998	5.63 (37.72)	34,666	4.19 (62.28)	None	---	55,664	1.26
Finish Flooring	None	---	None	---	None	---	None	---
Roof Sheathing	289,434	77.60 (7.61)	515,758	62.29 (13.56)	2,997,970	93.57 (78.83)	3,803,162	86.34
Wall Sheathing	34,701	9.30 (9.66)	124,466	15.03 (34.65)	200,000	6.24 (55.68)	359,167	8.15
Soffits	None	---	99,394	12.00 (100)	None	---	99,394	2.26
Panel (Wall)	1,866	.50 (100)	None	---	None	---	1,866	.04
Other	4,800	1.29 (7.46)	53,684	6.48 (83.43)	5,860	.18 (9.10)	64,344	1.46
Totals	372,974	100	827,968	100	3,203,830	100	4,404,772	100
c) Combined								
Subflooring	90,039	12.08 (84.57)	13,434	.75 (12.62)	3,000	.07 (2.82)	106,473	1.51
Underlayment	60,981	8.18 (55.90)	48,100	2.68 (44.10)	None	---	109,081	1.55
Finish Flooring	14,333	1.92 (100)	None	---	None	---	14,333	.20
Roof Sheathing	520,142	69.79 (8.51)	1,382,066	76.92 (22.61)	4,211,526	93.75 (68.89)	6,113,734	86.91
Wall Sheathing	47,655	6.39 (9.73)	173,321	9.65 (35.37)	269,024	5.99 (54.90)	490,000	6.97
Soffits	5,450	.73 (4.05)	126,081	7.02 (93.72)	3,000	.07 (2.23)	134,531	1.91
Panel (Wall)	1,866	.25 (100)	None	---	None	---	1,866	.03
Other	4,800	.64 (7.46)	53,684	2.99 (83.43)	5,860	.13 (9.11)	64,344	.91
Totals	745,266	100	1,796,686	100	4,492,410	100	7,034,361	100

¹ Percentages in parenthesis are calculated on row totals.

sq. ft. The interval for the average amount of softwood used by the large firms without consideration of applications was 322,145 \pm 238,274 sq. ft. In all cases there were considerable differences in amounts used from firm to firm. Similar findings were evident for the personal interview sample.

Firms in the personal interview sample also used the largest share (86 percent) of their softwood for roof sheathing (Table 24). The smallest share of the plywood was used for wall paneling. The largest application of plywood by firms in each of the size classes also was roof sheathing.

All of the softwood used for subflooring and wall paneling was accounted for by the small firms. Middle sized firms accounted for the largest share of the total plywood used for underlayment, soffits and other applications. Large firms accounted for the largest share of the plywood used for roof sheathing and wall sheathing.

TESTS OF THE SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE TWO SAMPLES

Tests of significance of the difference between the mail population and the personal interview population show that there was no significant difference between the two populations in general (Appendix Table IV). The only point of difference in the two populations according to the tests was in the usage per builder of plywood for wall paneling. The test indicated that the average amount of plywood usage for this application was larger for firms in the personal interview population than for firms in the mail questionnaire population.

Results of the tests seem to be inconsistent with the fact that average amounts of plywood used in the applications by firms of the personal interview sample were larger in almost every case than those for firms in the mail sample. However, it must be remembered that

the number of firms in the mail sample was greater than that of firms in the personal interview sample.

Tests of significance of the difference between the mean values of plywood usage per house constructed by all firms in the two samples also denoted that there was no significant difference between the two samples. The amounts of softwood plywood used by the builders per house showed that both samples used approximately the same amounts for each of the specific applications.

Data from these builders were inconclusive with respect to applications for hardwood plywood and the species used. It appeared that wall paneling accounted for the largest share of the hardwood. Some hardwood was also used for cabinets, finish flooring, and decor. Birch, mahogany, and fir were the major species used.

PLYWOOD USED BY SUBCONTRACTORS OF SINGLE FAMILY HOMES

Subcontractors of single family home construction that responded to mail questionnaires and personal interviews used 848,506 sq. ft. of softwood plywood and 33,140 sq. ft. of hardwood plywood during 1966 (Table 25). Firms in the personal interview sample accounted for 787,290 sq. ft. of the softwood and 30,840 sq. ft. of hardwood plywood. There were 10 builders in the personal contact sample and 3 in the mail sample. Firms in the personal contact sample were mainly large firms which did specialized work on large numbers of houses.

The average amount of softwood used by the mail sample firms was 20,405 sq. ft. and the average amount of hardwood was 767 sq. ft. Firms in the personal contact sample used an average of 78,729 sq. ft. of softwood and 3.084 sq. ft. of hardwood plywood in their work.

Table 25. Amounts of Plywood Used by Sub Contractors
of Single Family Homes, Arizona, 1966
(3/8" Basis for Softwood)

Plywood Used	a)Mail Sample		b)Personal Interv.		c)Combined Data	
	Amt. in Sq. Ft.	Ave. Amt. Sq. Ft.	Amt. in Sq. Ft.	Ave. Amt. Sq. Ft.	Amt. in Sq. Ft.	Ave. Amt. Sq. Ft.
Softwood	61,215	20,405	787,290	78,729	848,505	65,270
Hardwood	2,300	767	30,840	3,084	33,140	2,549

TYPES OF WORK DONE BY SUBCONTRACTORS

The builders in the mail sample worked on 20 houses of which 18 were new houses (Table 26). The firms in the personal interview sample worked on 760 new houses and were engaged in remodeling or repairing 152 houses. These contractors remodeled and repaired an average of 15 houses each and worked on 76 new houses per subcontractor.

Table 26. Types of Work Done by Sub Contractors
of Single Family Homes, Arizona, 1966.

Type of Work	a) Mail Sample		b) Personal Interview		c) Combined Data	
	Total No. Houses	Average Number	Total No. Houses	Average Number	Total No. Houses	Average Number
Remodeling or Repair	2	.66	152	15	154	12
Work on New Structures	18	6.00	760	76	778	60
Total No. Worked	20		912	91	932	72

AMOUNTS OF SOFTWOOD PLYWOOD USED IN SPECIFIC APPLICATIONS

The firms in the mail sample used over 91 percent of their softwood for roof sheathing and siding was the next largest application requiring about 6 percent of the total softwood. All confidence intervals except that

for the mean value of plywood usage for roof sheathing contained negative lower limits. The interval for roof sheathing for the firms was $18,666 \pm 7,914$ sq. ft.

Firms in personal interview sample also used over 90 percent of their softwood plywood for roof sheathing while slightly over 5 percent of it was used for cabinets in the "other" category (Table 27). Confidence intervals of the true means of the data of these firms were similar to the mail sample. One difference was that the interval for the mean value of plywood usage without regard for application by these firms did not have a negative lower limit. The interval was $78,729 \pm 65,693$ sq. ft. which shows that for purposes of estimating this quantity the sample was adequate but the variation was considerable.

SIGNIFICANCE OF THE DIFFERENCE BETWEEN THE MAIL SAMPLE AND THE PERSONAL INTERVIEW SAMPLE

Tests of significance of the difference between the two samples show that overall there was no significant difference between the two mean values for total plywood usage even though the sample mean for total plywood usage by firms in the mail sample was 20,405 sq. ft. and that for firms in the personal interview sample was 78,729 sq. ft. The sizes of the respective samples and the variation among the firms explain this result.

There was no significant difference between the mean values of any of the specific applications except subflooring and siding. The tests of significance for these two applications indicated that mean amounts of plywood usage for them were greater by firms in the mail sample than in the personal interview sample.

Table 27. Amounts of Softwood Plywood Used in Various End Uses
by Sub Contractors of Single Family Homes, Arizona, 1966.
(3/8" Basis)

Use	a) Mail Sample			b) Personal Interview			c) Combined Data		
	Amt. in Sq. Ft.	% of Total	Ave. Amt. Sq. Ft.	Amt. in Sq. Ft.	% of Total	Ave. Amt. Sq. Ft.	Amt. in Sq. Ft.	% of Total	Ave. Amt. Sq. Ft.
Roof Sheathing	55,999	91.48	18,666	711,309	90.35	71,131	767,308	90.43	59,024
Roof Decking	None	---	---	15,300	1.94	1,530	15,300	1.80	1,177
Wall Sheathing	None	---	---	5,953	.76	595	5,953	.70	458
Subflooring	1,133	1.85	378	None	---	---	1,133	.13	87
Floor Underlayment	None	---	---	None	---	---	None	---	---
Siding	3,667	5.99	1,222	None	---	---	3,667	.43	282
Paneling	None	---	---	6,528	.83	653	6,528	.77	502
Soffits	None	---	---	None	---	---	None	---	---
Other (Cabinets)	None	---	---	42,867	5.44	4,287	42,867	5.05	3,298
Concrete Formwork	417	.68	139	5,333	.68	533	5,750	.68	442
Total Amounts	61,215	100	20,405	787,290	100	78,729	848,506	100	65,270

SPECIFIC APPLICATIONS FOR HARDWOOD PLYWOOD

Firms in the mail sample reported using only 2,300 sq. ft. of hardwood plywood during 1966. Applications for which it was used and species of plywood are shown in Appendix Table X. Firms in the personal interview sample used over 30,000 sq. ft. of hardwood plywood. A little over 48 percent of the total was used for wall paneling and nearly 52 percent was used for cabinet work.

SOURCES OF PLYWOOD

Plywood used by firms in the mail sample was purchased from two different sources (Table 28). Nearly 62 percent of the softwood and 65 percent of the hardwood plywood was purchased from wholesale or retail dealers located within the study area. Mills outside of the study area were the other source of supply.

The amounts that came from mills outside the study area are difficult to explain. Subcontractors who use no more plywood than was reported by these firms probably would not buy direct from mills unless they were geographically near the mills. This may have been the case for respondents to the mail questionnaire operating in the fringe areas of the state. All of the plywood used by the firms in the personal interview sample was purchased from wholesale or retail dealers located inside the study area.

Table 28. Sources of Plywood Used by Sub Contractors
of Single Family Homes, Arizona, 1966.
(3/8" Basis for Softwood)

Sources	a) Mail Sample				b) Personal Interview				c) Combined Data			
	Softwood		Hardwood		Softwood		Hardwood		Softwood		Hardwood	
	Amount Sq. Ft.	% of Total	Amount Sq.Ft.	% of Total	Amount Sq.Ft.	% of Total	Amount Sq.Ft.	% of Total	Amount Sq.Ft.	% of Total	Amount Sq.Ft.	% of Total
From Mills												
In Study Area	None	---	None	---	None	---	None	---	None	---	None	---
Outside Study Area	23,384	38.2	800	34.7	None	---	None	---	23,384	2.76	800	2.41
From Whlse. or Retail Dlrs.												
In Study Area	37,831	61.8	1,500	65.3	787,290	100	30,840	100	825,121	97.24	32,340	97.59
Outside Study Area	None	---	None	---	None	---	None	---	None	---	None	---
From Other Sources												
In Study Area	None	---	None	---	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---	None	---	None	---
Total	61,215	100	2,300	100	787,290	100	30,840	100	848,505	100	33,140	100

PLYWOOD USED BY MANUFACTURERS

Manufacturers who responded to the mail questionnaire reported using 1,063,813 sq. ft. of softwood and 685,056 sq. ft. of hardwood plywood during 1966. Nearly all of this was used by these manufacturers in products that were made for sale (Table 29). The average amount of softwood used in products for sale by each firm was 81,699 sq. ft. and they averaged 52,697 sq. ft. of hardwood.

Table 29. Purposes for Which Plywood Was Used
by Manufacturers in Arizona, 1966.
(3/8" Basis for Softwood)

	Total Amt.	% of Total	Aver. Amt. Sq. Ft.	Total Amt.	% of Total	Aver. Amt. Sq. Ft.
Products For Sale	1,060,093	99.65	81,699	685,056	100	52,697
Products For Own Use	3,400	.32	262	None	---	---
Other	320	.03	25	None	---	---
Total Amount Used	1,063,813	100		685,056	100	

SOURCES OF PLYWOOD USED BY MANUFACTURERS

The largest amounts of both softwood and hardwood were obtained from dealers located inside the study area (Table 30). Over 49 percent of the softwood used by these firms and almost 78 percent of the hardwood plywood was from dealers inside the study area. However, about 43 percent of the softwood and 22 percent of the hardwood purchased by these firms was obtained from dealers located outside the study area.

Table 30. Sources of Plywood Used by
Manufacturers in Arizona, 1966.
(3/8" Basis for Softwood)

Source	Softwood		Hardwood	
	Amount	% of Total	Amount	% of Total
From Mill				
In Study Area	None	---	None	---
Outside Study Area	80,000	7.52	None	---
From Wholesale or Retail Dealer				
In Study Area	523,013	49.16	531,406	77.57
Outside Study Area	460,800	43.32	153,600	22.42
From Other Sources				
In Study Area	None	---	None	---
Outside Study Area	None	---	50	.01
<u>Total Amount</u>	<u>1,063,813</u>	<u>100</u>	<u>685,056</u>	<u>100</u>

AMOUNTS OF PLYWOOD USED BY END USE

About 96 percent of both softwood and hardwood were used in the manufacture of cabinets (Table 31). Furniture was the next largest use for softwood (two percent), while campers absorbed the second largest amount of hardwood (3.5 percent).

Many species of hardwood were preferred in some manner or other by manufacturers but birch was most often designated as the most important species used. Ash, walnut, and mahogany were preferred by some of the manufacturers.

Table 31. Amounts of Plywood Used by Manufacturers
by End Uses, Arizona, 1966.
(3/8" Basis for Softwood)

Uses	Softwood		Hardwood	
	Amount Sq. Ft.	% of Total	Amount Sq. Ft.	% of Total
Campers	8,200	.77	24,000	3.50
Cabinets	1,030,376	96.86	660,556	96.42
Furniture	18,445	1.73	500	.07
Picture Frames and Crating	2,272	.2	None	---
Sailboats	800	.1	None	---
Other	3,720	.35	None	---
Total	1,063,813	100	685,056	100

PLYWOOD DISTRIBUTION BY WHOLESALE AND RETAIL LUMBER DEALERS

Data reported by wholesale and retail lumber dealers was not reported on a 3/8" basis and the questionnaire contained no information to facilitate a conversion of the amounts of softwood plywood to this uniform thickness. As a result it was necessary to use an approximate method of converting the amounts. This was done by making several assumptions. Since it was known approximately how much plywood was shipped into the Phoenix major trade area (65,000,000 square feet)¹⁸ and the thicknesses of these amounts, it was possible to calculate the percentage of the total that was of each thickness. Since it was assumed that the responding firms were representative of all firms in the population, the total amounts of softwood plywood purchased by these firms would approximate the thicknesses of the plywood shipped to all firms in the study area. The total amounts of softwood plywood purchased by the responding firms were broken down by percentages for each thickness and conversions made to the uniform 3/8" basis.

AMOUNTS OF SOFTWOOD PLYWOOD HANDLED

Wholesale and retail lumber distributors responding to the mailed questionnaires handled 57,086,424 sq. ft. of softwood plywood in the study area during 1966 and 1,726,822 sq. ft. of hardwood plywood. (No effort was made to personally interview these dealers.) The softwood volume appears to account for about 88 percent of the inshipments.

¹⁸Yerkes, V. P., Lloyd, R. D. and Lewis, G. D., Softwood Plywood Production in the United States - Production and Distribution in 1965, U.S. Forest Service Research Paper RM-34, Table 7, p. 13.

There were some distinct differences between different size groups of these distributors. The 27 firms which handled less than 250,000 sq. ft. of plywood each represented more than 64 percent of the total number sampled and they purchased 3 percent of softwood plywood and 8 percent of the hardwood plywood (Tables 32 and 33). The 10 medium sized firm purchased

Table 32. Percentage Shares and Amounts of Softwood Plywood
Purchased by Wholesale and Retail Dealers, Arizona, 1966.
(3/8" Basis)

Firms Purchasing	No. of Dealers	% of Total	Amt. Handled Sq. Ft.	% of Total
Less than 250,000 sq. ft.	27	64.20	1,484,247	2.60
250,000 to 1 million	10	23.80	6,564,939	11.50
Over 1 million	5	12.00	49,037,238	85.90
Totals	42	100	57,086,424	100

about percent of softwood and 27 percent of the hardwood plywood. The five remaining firms, those handling over 1 million sq. ft. of plywood, purchased over 85 percent of the reported softwood plywood and 65 percent of the hardwood plywood.

Table 33. Percentage Shares and Amounts of Hardwood Plywood
Purchased by Wholesale and Retail Dealers, Arizona, 1966.

Firms Purchasing	No. of Dealers	% of Total	Amt. Handled Sq. Ft.	% of Total
Less than 250,000 sq. ft.	27	64.2	133,622	7.8
250,000 to 1 million	10	23.8	468,000	27.1
Over 1 million	5	12.0	1,125,200	65.1
Totals	42	100	1,726,822	100

SOURCES OF SOFTWOOD PLYWOOD HANDLED

About 83 percent of the softwood plywood handled by the respondent firms came from mills located outside the study area. Dealers located inside the study area supplied 15 percent of the plywood handled by other dealers. This amount is probably counted twice as far as accounting for plywood inshipment into the market area is concerned. The total amount of plywood accounted for by the sample is therefore closer to 75 percent than to the 88 percent mentioned previously.

The smallest handlers of plywood purchased 59 percent of their total softwood from dealers within the study area. Firms in the other two groups purchased their largest amounts from mills outside of the study area. This points out the fact that larger handlers of plywood bypassed the dealers in the study area and purchased the largest amounts of their softwood directly from the producing mills while small lot dealers purchased from larger dealers.

SOURCES OF HARDWOOD PLYWOOD HANDLED

The largest plywood handlers purchased hardwood plywood from four different sources. About 48 percent of their hardwood supply came directly from mills outside the area, another 29 percent came from other sources outside of the study area and 20 percent was obtained from other dealers within the study area (Table 35).

About 57 percent of the total hardwood handled by firms which sold between 250,000 sq. ft. to 1 million sq. ft. of plywood was obtained from dealers inside the study area and another 38 percent was obtained from mills located outside of the study area. Firms of the smallest size group showed less tendency to purchase hardwood from sources outside of the study area than either of the other groups.

Table 34. Sources of Softwood Plywood Handled by
Wholesale and Retail Dealers, Arizona, 1966.
(3/8" Basis)

Sources	Firms Purchasing Less Than 250,000 Sq.Ft. Amt. in Sq.Ft.	% of Total ¹	Firms Purchasing 250,000 to 1 Mill. Sq.Ft. Amt. in Sq. Ft.	% of Total	Firms Purchasing Over 1 Mill. Sq.Ft. Amt. in Sq. Ft.	% of Total	Total Amount From Each Source Sq. Ft.	% of Total From Each Source
From Mills								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	120,224	8.10 (.25)	4,982,789	75.90 (10.45)	42,564,323	86.80 (89.29)	47,667,336	83.50
From Wholesale or Retail Dlrs.								
In Study Area	875,706	59.00 (10.08)	1,582,150	24.10 (18.22)	6,227,729	12.70 (71.70)	8,685,585	15.21
Outside Study Area	488,317	32.90 (66.57)	None	---	245,186	.50 (33.43)	733,503	1.28
From Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Totals	1,484,247	100	6,564,939	100	49,037,238	100	57,086,424	100

¹Percentages in parenthesis denote the shares of the total plywood from each source that was purchased by each size group of firms.

Table 35. Sources of Hardwood Plywood Handled by
Wholesale and Retail Dealers, Arizona, 1966.

Sources	Firms Purchasing Less Than 250,000 Sq.Ft.		Firms Purchasing 250,000 to 1 Mill.		Firms Purchasing Over 1 Mill.		Total	% of
	Amt. in Sq. Ft.	% of Total ¹	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total	Amount From Each Source Sq. Ft.	Total From Each Source
From Mills								
In Study Area	None	---	None	---	None	---		
Outside Study Area	None	---	180,000	38.4 (25.05)	538,600	47.9 (74.95)	718,600	41.61
From Wholesale or Retail Dlrs.								
In Study Area	87,422	65.4 (14.48)	268,000	57.2 (44.40)	248,200	22.1 (41.12)	603,622	34.96
Outside Study Area	46,200	34.6 (100)	None	---	None	---	46,200	2.68
Other Sources								
In Study Area	None	---	None	---	12,800	1.1 (100)	12,800	.74
Outside Study Area	None	---	20,000	4.2 (5.79)	325,600	28.9 (44.21)	345,600	20.01
Total	133,622	100	468,000	100	1,125,200	100	1,726,822	100

¹Percentages in parenthesis denote the shares of the total plywood from each source that was purchased by each size group of firms.

DISPOSAL OF PLYWOOD

Tables 36 and 37 show the distribution of softwood and hardwood plywood that was purchased by dealers during 1966. The largest amounts of each were sold to others while only small amounts were used within the purchasing firms.

Table 36. How Softwood Plywood Was Disposed of by
Wholesale and Retail Dealers, Arizona, 1966.
(3/8" Basis)

Firms Purchasing	Sold to Others ¹		Used Within Firm		Total Amt. for	
	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total	Each Group	% of Total
250,000 sq.ft.	1,300,800	2.30 (95.94)	55,056	88.40 (4.06)	1,355,856	2.39
250,000 to 1 Million sq.ft.	6,390,888	11.30 (99.89)	7,225	11.60 (.11)	6,398,113	11.30
1 Mill. sq.ft.	48,864,845	86.40 (100)	None	----	48,864,845	86.30
Total	56,556,534	100	62,281	100	56,618,815	100

¹Percentages in parenthesis are calculated on row totals.

Of the total amount of softwood sold to others, over 86 percent was accounted for by the largest firms. Of the total amount of softwood that was used within the purchasing firms, over 88 percent was used by the smallest firms but this represented only 4 percent of the softwood plywood handled by these firms.

Distribution of hardwood plywood was similar to softwood. The largest share was accounted for by the big firms and very little of the hardwood was used within the dealer firms.

Table 37. How Hardwood Plywood Was Disposed of by Wholesale and Retail Dealers, Arizona, 1966.

Firms Purchasing	Sold to Others ¹		Used Within Firm		Total Amt. for Each Group	% of Total
	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total		
250,000 sq.ft.	128,066	7.6 (99.84)	200	100 (.16)	128,266	7.67
250,000 to 1 Million sq.ft.	421,000	25.2 (100)	None	---	421,000	25.18
1 Mill. sq.ft.	1,122,400	67.2 (100)	None	---	1,122,400	67.14
Total	1,671,466	100	200	100	1,671,666	100

¹Percentages in parenthesis are calculated on row totals.

WHERE PLYWOOD WAS SOLD BY DEALERS

In tables 38 and 39, the amounts in the "Total Amount Sold" columns are identical to the amounts in the "Sold to Others" columns in Tables 36 and 37.

Over 97 percent of the total softwood sold to others was sold within the study area. The remaining 3 percent left the study area. Over 98 percent

Table 38. Where Softwood Plywood Was Sold by Wholesale and Retail Dealers, Arizona, 1966.

Firms Purchasing	Outside Study Area ¹		Inside Study Area		Total Amt. Sold	% of Total
	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total		
250,000 sq.ft.	88,715	5.96 (6.82)	1,212,085	2.2 (93.18)	1,300,800	2.30
250,000 to 1 Million sq.ft.	226,877	15.24 (3.55)	6,164,012	11.19 (96.45)	6,390,888	11.30
1 Mill. sq.ft.	1,172,756	78.79 (2.40)	47,692,089	86.61 (97.60)	48,864,845	86.40
Total	1,488,348	100	55,068,186	100	56,556,534	100

¹Percentages in parenthesis are calculated on row totals.

of the hardwood sold to others was sold inside the study area while less than 2 percent of the hardwood sold to others left the study area.

Table 39. Where Hardwood Plywood Was Sold by Wholesale and Retail Dealers, Arizona, 1966.

Firms Purchasing	Outside Study Area ¹ Amt. in Sq. Ft.	% of Total	Inside Study Area Amt. in Sq. Ft.	% of Total	Total Amt. Sold	% of Total
250,000 sq.ft.	16,600	71.5 (12.96)	111,466	6.7 (87.04)	128,066	7.66
250,000 to 1 Million sq.ft.	None	---	421,000	25.6 (100)	421,000	25.19
1 Mill. sq.ft.	6,630	28.5 (.59)	1,115,770	67.7 (99.41)	1,122,400	67.15
Total	23,230	100	1,648,236	100	1,671,466	100

¹Percentages in parenthesis are calculated on row totals.

GROUPS TO WHOM PLYWOOD WAS SOLD INSIDE THE STUDY AREA

The largest amount of softwood plywood handled by dealers was sold to contractors (38 percent), while the second largest amount was sold to other dealers (29 percent) (Table 40). Approximately 25 percent of the softwood plywood sold in the study area was sold to the farm and ranch, do-it-yourself, and "other users" markets. None of these users were contacted concerning their plywood usage but they seem to be a much more important plywood consumers than was anticipated. Implications about these markets and the potential they hold for future plywood consumption would be speculative without more information.

The largest proportion softwood sales by each of the three size groups of firms was to contractors. The smallest amount of softwood

Table 40. Groups to Whom Softwood Plywood Was Sold Inside
the Study Area, Arizona, 1966.

To Whom Sold	250,000 Sq.Ft. ¹		250,000 to 1 Million Sq.Ft.		1 Million Sq.Ft.		Total Amt.	
	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total	Sold in Sq. Ft.	% of Grand Total
Other Dealers	32,726	2.70 (.20)	733,517	11.90 (4.58)	15,261,469	32.00 (95.22)	16,127,712	29.11
Contractors	562,407	46.40 (2.69)	3,858,672	62.60 (18.44)	16,501,463	34.60 (78.87)	20,922,542	37.99
Industrial Users	16,969	1.40 (.38)	252,725	4.10 (5.66)	4,196,904	8.80 (93.96)	4,466,598	8.11
Farms and Ranches	75,149	6.20 (11.83)	178,756	2.90 (28.13)	381,537	.80 (60.04)	635,442	1.15
Do-it-Yourself	482,410	39.80 (8.77)	628,729	10.20 (11.43)	4,387,672	9.20 (79.79)	5,498,811	9.99
Other Users	42,423	3.50 (.56)	511,613	8.30 (6.81)	6,963,045	14.60 (92.63)	7,517,081	13.65
Total	1,212,085	100	6,164,012	100	47,692,089	100	55,068,186	100

¹Percentages in parenthesis are calculated on row totals.

sold by the group of firms handling 250,000 sq. ft. or less of plywood was to industrial users. The larger plywood dealers sold least to the farm and ranch market.

The largest amount of hardwood plywood was sold to the do-it-yourself market while contractors purchased the second largest amount (Table 41).

Table 41. Groups to Whom Hardwood Plywood Was Sold Inside
the Study Area, Arizona, 1966.

To Whom Sold	250,000 Sq.Ft. ¹		250,000 to 1 Million Sq.Ft.		1 Million Sq.Ft.		Total Amt. Sold in Sq. Ft.	% of Grand Total
	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total		
Other Dealers	880	.7 (.21)	166,200	39.4 (39.59)	252,713	22.7 (60.20)	419,793	25.47
Contractors	37,010	33.3 (8.09)	123,650	29.4 (27.03)	296,853	26.7 (64.88)	457,513	27.76
Industrial Users	625	.5 (1.08)	3,100	.8 (5.35)	54,252	4.8 (93.58)	57,977	3.52
Farms and Ranches	6,280	5.6 (29.37)	5,100	1.2 (23.85)	10,000	.8 (46.77)	21,380	1.30
Do-it-Yourself	66,591	59.8 (11.66)	80,300	19.1 (14.07)	424,000	38. (74.27)	570,891	34.64
Other Users	80	.1 (.07)	42,650	10.1 (35.34)	77,951	7.0 (64.59)	120,681	7.32
Total	111,466	100	421,000	100	1,115,769	100	1,648,235	100

¹Percentages in parenthesis are calculated on row totals.

SOFTWOOD CONSUMPTION IN THE PHOENIX MAJOR TRADE AREA

One of the study objectives was to estimate the total quantity of plywood that was consumed in the area during the year. This information has been tabulated in Table 42. The conclusion to be drawn from these data is that 97 percent of all softwood plywood shipped into the area, or produced and sold within the area by mills, was consumed in the area. By applying this percentage to the 64 million square feet of plywood shipped into the Phoenix major trade area during 1966,¹⁹ we could estimate that 62,080,000 square feet was consumed within the area. This estimate would be somewhat low if home manufacturers and mobile home manufacturers purchased a significant amount of material from mills or dealers located outside of the trade area.

The questionnaires seem to be constructed in such a manner that consumption in a major trade area can be closely estimated.

¹⁹Op. cit.

Table 42. Estimate of Softwood Plywood ^{2.} Consumption in the Phoenix Major Trade Area, 1966.

Handler or User	Column (1) Imports to the Area (sq. ft.)	Column (2) Production within the Area (sq. ft.)	Column (3) Exports from the Area	Column (4) Net Amount Remaining in Area (Col. 1 + Col. 2 - Col. 3) (sq. ft.)	Column (5) Percent Remaining in Area Column 4 + Col. 1 + Col. 2
Dealers ¹	48,400,839	N/A	1,488,348	46,912,491	95
Principal Contractors ² for nonresident const.	4,300	N/A	0	4,300	100
Subcontractors of nonresidential const. ³	287,623	N/A	0	287,623	100
Principal contractors ⁴ of single family homes	189,225	N/A	0	189,225	100
Subcontractors ⁵ of single family homes	23,384	N/A	0	23,384	100
Manufacturers ⁶	540,800	N/A	0	540,800	100
Home manufacturers ⁷	0	N/A	0	0	0
Mobile home manufacturers ⁷	0	N/A	0	0	0
Mills ⁸	0	0	0	0	0
Total	49,446,171	0	1,488,348	47,957,823	97

¹Data from Table 34 and 38.

²Data from Table 8.

³Data from Table 16.

⁴Data from Table 23.

⁵Data from Table 28.

⁶Data from Table 30

⁷No response to questionnaire.

⁸There are no plywood mills in this area.

STUDY PHASE THREE REASONS FOR USING MATERIALS IN DIFFERENT END USES

The quantitative data obtained in the first two phases of this study provided detailed information regarding the amounts of plywood used, the purposes for which plywood was used, the types of structures built, and channels through which plywood was marketed. However, a very important type of information is lacking. These data say nothing about the reasons for using different materials in the several construction end uses. This type of qualitative information is equally as important as quantitative data in guiding the activities of building materials producers, handlers, and researchers.

The task of accumulating the qualitative information was undertaken during the summer of 1968. The methodology for this project was described previously on page 10. As mentioned, the firms interviewed were selected from the list of building and construction firms who had responded to earlier mailed and personal interview questionnaires. This increased the difficulty in obtaining cooperation from plywood users. Since they had been previously contacted and responded to the mail questionnaires or personal interviews, many firms hesitated to spend an additional 30-90 minutes to answer the questions regarding the qualitative factors involved in choosing materials for different uses. Subsequently, almost all of the firms on the list, that were located in the Phoenix and Tucson metropolitan areas, were contacted in an effort to establish a meeting time to conduct the personal interviews. Excuses and complications were of such magnitude that the number of interviews was limited to about 200 during the time period available for field work. The information that follows is summarized from data that were obtained from participating firms regarding the factors that are important in choosing materials for

different end uses.

ROOF SHEATHING MATERIALS

There were 134 firms in the sample that reported building structures which required roof sheathing. Plywood was the principal material used for this purpose by 102 of these firms (Table 43). This finding is consistent with the results evident in the quantitative data which showed that roof sheathing absorbed the largest amount of plywood used by contractors of single family homes, apartments, and nonresidential buildings. Other materials mentioned as substitutes for this use were pine lumber, concrete and steel. The most important reason for using the materials indicated was prices paid for materials (Table 44). Of lesser importance in explaining the reasons for use of plywood materials were performance of material and cost of installation.

Table 43. Type of Material Used for Different Construction Applications, Arizona, 1968

Material Used	Roof Sheathing	Wall Sheathing	Soffits	Exterior Siding	Subflooring	Underlayment	Finish Floor	Form Work	Decking	Interior Panel	Cabinet Work	Shelving & Millwork
						Number of Firms						
Plywood	102	69	34		12	13		161	11	37	71	64
Steel	13	5		1								6
Concrete	9	16		12	96	68	3					
Pine	6											
Concrete Block		21	1	68								
Masonry		9										
Text 1-11			13	8								
Hardboard			12	4		2						
Open			8									
Particle Board			4							1	23	20
Prest Wood			1								4	3
Hardwood			4									
Cedar Plywood				5								
Redwood Plywood				5								
Brick				5								
Felt						6						
Foam						5						
Carpet							44					
Tile							34					
"3x"									13			
"2x"									8			
"2 x 10"									4			
Pre Built								1			4	3
Pre Finished										33		
Walnut Finish										9		
Oak										5		
Gypson Board										4	1	1
Other*	4	3	13	1	0	4	6	4	11	4	7	7
Total	139	123	90	109	108	98	87	165	47	93	110	104

*Those with a total of three or less responses for a given end use.

TABLE 44. Reasons for Material Selection for Different Construction Applications, Arizona, 1968

Material Used	Reasons ¹												
	a	b	c	d	e	f	g	h	i	j	k	l	m
Roof Sheathing													
No. of firms listing reason as 1st, 2nd or 3rd importance													
Plywood	82	38		1			1	5	42			1	2
Steel	1							1	2				
Concrete	1							2	3				
Pine ²	4							1	6				
Others ²	2	2						2	3				
Total	90	40		1			1	11	56			1	2
Wall Sheathing													
Plywood	57	22						2	22				
Block	5	2					3	1	15	1			4
Concrete	1							2	3				
Masonry	2	2	1					2	6				1
Steel ²	1							1	2				
Others ²		1						1	2				
Total	66	27	1				3	9	50	1			5
Soffits													
Plywood	26	4						1	3	6		3	
Text 1-11	1								6	1		2	
Masonite	4								12				1
Open	2								2				
Particle Board	2	1							1	1			
Hardwood	2												
Other ²	3	4							6	2		1	
Total	40	9						1	30	10		6	1
Exterior Siding													
Concrete Block	6		2	1			24		49	5	1	2	
Concrete							1		2			1	
Text 1-11									2	4			
Redwood or Cedar Plywood	3	4							1			5	
Hardboard	2	2						2	2				2
Brick ²									3		1	2	
Other ²	1								1	2		3	
Total	12	6	2	1			25	2	60	11	2	13	2
Subflooring													
Concrete	20	6					3		68				16
Plywood	2								2				
Total	22	6					3		70				16
Underlayment													
Concrete	17	4					1	2	38				11
Plywood	7								10				1
Felt									3		3		
Foam ²											5		
Other ²	1							4	4				
Total	25	4					1	6	55		8		12

TABLE 44. Reasons for Material Selection for Different Construction Applications, Arizona, 1968 - Continued

Material Used	Reasons ¹												
	a	b	c	d	e	f	g	h	i	j	k	l	m
			Finish Flooring										
Carpet	8						1		23	1	33	2	
Tile	8	1							17	3	12	4	1
Other ²	1	3					1		8		2	1	1
Total	17	4					2		48	4	47	7	2
			Form Work										
Plywood	133	52					5		88				1
Other ²	2								2				
Total	135	52					5		90				1
			Decking										
"3x"									13				
Plywood	3							1	2				
"2x"									8				
"2 x 10"	1	1							4				1
Other ²	4	1						3	10			1	3
Total	8	2						4	37			1	4
			Interior Panel										
Pre Finished & Finished	15	2					2	2	10		29	19	
Plywood	1	1							2		12		
Walnut Finish	1								1		5	8	
Redwood Plywood	4	5							1		2	2	
Oak									2	2		2	
Gypson Board								1	2		1	1	
Birch Plywood	3	2							2		1	1	
Other ²	5	4							3	1	3	3	
Total	29	14					2	3	23	3	53	36	
			Cabinet Work										
Plywood	52	19					1		18	4		2	1
Particle Board	14	4					1		11	3	1	1	1
Prest Wood	1								3	1			1
Manufactured							1		2				
Other ²	5	3							9	2	4		3
Total	72	26					3		43	10	5	3	6
			Shelving & Millwork										
Plywood	50	18					3		21	5	2	2	
Particle Board	14	4					2		9	3	2		1
Steel									1		2		
Other ²	6	1					1		11	1			2
Total	70	23					6		42	9	6	2	3

- ¹
- Prices paid for materials
 - Cost of installation
 - Reputation of manufacturer
 - Guarantees and warranties
 - Credit and financing
 - Manufacturer and distributor assistance (on-site delivery, precutting, packaging, etc.)

- g. Ease of procurement
- h. Building code, FHA, VA, etc., requirements
- i. Performance
- j. Ease and durability of finishing
- k. Customer preference (fashions, fads, etc.)
- l. Architectural appearance
- m. Other (specify)

²Those materials reported used by three or fewer firms.

square foot. Those firms that purchased by thousand square feet reported a mean price of \$99.85 per thousand, with a range price of \$90-\$110 per thousand and the modal price was \$110 per thousand square feet. The mean price of substitutes used by six of the reporting firms was 17.66 cents per square foot.

The cost of installation, reported as the second most important reason for using plywood for roof sheathing, averaged 12.63 cents per square foot with the modal cost being 11 cents per square foot. The response on the cost of installing other materials was not reported in dollar amounts but 13 of the respondents indicated that it would cost more to apply other material.

Performance was listed as the third most important reason for using plywood for roof sheathing. The principal desirable characteristics of plywood were that it goes on easily, that it goes on quickly, and that it is workable.

Although respondents indicated that price of material was the main reason for choosing plywood over other materials, when one considers the remaining expressed justifications it is evident that total in place cost is the important over all consideration.

WALL SHEATHING MATERIALS

There were 123 firms in the sample that reported using wall sheathing

materials. Sixty-nine of these firms reported using some plywood for this purpose, 21 used concrete block and 16 respondents used concrete. By far the most frequent explanation for using plywood was prices paid for materials. Cost of installation and performance of material were other reasons given for using plywood. The average price paid for plywood used in wall sheathing was 17.19 cents per square foot delivered and 15.50 cents picked up at the lumber yard. The range in prices paid was 10 to 25 cents per square foot delivered and 14 to 16 cents per square foot at the dealers yard. The modal prices were 18 cents per square foot delivered and 16 cents per square foot at dealers yard. The response received on prices paid for substitute products was not sufficient to be meaningful.

The 22 firms that reported cost of installation as being an important reason for selecting plywood for wall sheathing had an average cost of 10.17 cents to apply it and the range was 5 to 14 cents per square foot. The information on cost of application for other materials was also too sketchy to be meaningful.

The 22 firms that reported performance of plywood as an important reason for using plywood in this application considered plywood to be easy to install, that it goes on quickly, and that it is workable. The main reason for using concrete block was that it is good insulation, that it is solid, and that it adds strength.

Although a relatively large number of firms in the sample used plywood for this purpose, the quantitative data indicated that the amount of plywood consumed was not large.

SOFFIT MATERIALS

There were 90 respondents that used materials for soffits. Of this

number 34 listed plywood as the principal materials used for this purpose. Thirteen of the respondents reported using Texture 1-11 and hardboard was the primary material chosen by twelve firms in the sample. The most usual explanation for using plywood was prices paid for materials. The average price paid was 14.54 cents per square foot delivered to the building site with 12 to 22 cents being the range in prices paid and the modal price was 14 cents per square foot delivered. The average cost for substitutes was said to be 15.14 cents per square foot delivered.

There was no predominant reason given for using Texture 1-11 but the main explanation for using hardboard was its performance. The most sought after characteristic for this use was weatherability. This characteristic was necessary because of extreme heat conditions in the Arizona area. Plywood was considered to perform unsatisfactorily in this respect because it requires a considerable amount of maintenance.

EXTERIOR SIDING MATERIAL

Concrete block was the principle material used for exterior siding while plywood was not used at all. The primary justification for selecting concrete block was its performance. Weather resistance was given as the unanimous desirable characteristic for materials exposed to the elements and plywood does not satisfactorily meet this requirement.

SUBFLOORING MATERIAL

The principal material used in subflooring was concrete. There were 108 firms that reported the use of material for this purpose but only 12 firms used plywood while concrete was used by 96 respondents. Performance was again suggested as the primary reason for selecting concrete. The three primary desirable characteristics of this material are that it is

solid, it does not deteriorate rapidly and it has strength. These characteristics were listed as needed mainly as a means to improve the structure and build a more sturdy structure.

UNDERLAYMENT MATERIAL

Concrete was also identified as the principal material used for underlayment. Sixty-eight of the respondents used concrete while plywood was used by only 13 firms. The major reasons for selecting concrete were prices paid for materials and the performance of concrete in this use. None of the firms interviewed indicated what price they would have to pay for plywood but all indicated that it would be more expensive for this use. The durability and solid strength of concrete were the most frequently mentioned desirable characteristics which served to "improve the structure and make a better floor."

FINISH FLOORING MATERIAL

Plywood was not used for finish flooring by any of the firms that participated in this phase of the study. Information obtained in the first phases of the study, however, revealed that some plywood was used for this purpose but it was of minor importance. The two most common materials used were carpet and tile. The two primary reasons for using these products were their performance and customer preference. The desirable characteristics most sought after in these products were that they are easy to maintain and that they wear well. Customers preferred these products because of appearance, color patterns, and the added living comfort. Only three respondents indicated that they frequently altered materials used because of changes in customer preference.

FORMWORK MATERIAL

This was the second most important application for plywood in the Arizona area in terms of quantity used. Almost all of the respondents preferred plywood over other formwork materials. The most frequent explanations for using plywood were prices paid for materials, its performance and installation cost. These same factors were suggested as reasons for using plywood as roof sheathing, the most important use for plywood in Arizona. Again, the over-riding factor is probably total in place cost.

The average price paid was 15.8 cents per square foot delivered to the building site and 14.6 cents at the dealers yard. The price range was 10 to 30 cents per square foot delivered to the building site and 10 to 20 cents per square foot at the lumber dealers yard. The modal price for form plywood delivered was 15 cents per square foot and for dealers yard purchases 13 cents per square foot was the modal price paid. The primary substitute material considered was rented forms, but it was practically unanimous that the cost of substitutes would be much more than that of plywood.

The average cost of installing plywood for formwork was 11.5 cents per square foot. The modal cost was 10 cents per square foot and the range was 2 to 25 cents per square foot. The response on the cost of other material used was not large enough to be meaningful. The most desirable characteristics of material used for this purpose were strength, ease of use and that it can be used several times in order to reduce the cost of material.

INTERIOR PANELING MATERIALS

Plywood and prefinished materials were the most commonly used materials for interior paneling. There was no predominant reason suggested to justify using plywood but customer preference was the most important reason for using prefinished materials. Customers preferred these materials because they gave a "good looking" finish.

CABINET WORK MATERIALS

Seventy-one of 110 respondents who used materials for cabinet work used plywood and 23 used particle board for this purpose. The primary reasons for selecting plywood were the cost and performance of materials.

The average price paid for plywood was 16.4 cents per square foot delivered and 15.2 cents per square foot dealers yard. The price range was 8 to 75 cents for material delivered at the building site and 12-18 cents per square foot for materials picked up at the dealers yard. The modal price for delivered plywood was 15 cents per square foot and for dealers yard it was 15.2 cents per square foot. Most respondents had not considered any other substitutes for cabinet work. The prices paid for particle board were even more varied than for plywood and therefore it is difficult to draw meaningful conclusions from the data.

The most desirable performance characteristic sought in cabinet work material was its workability of material. Many respondents held the opinion that plywood did not work well.

SHELVING AND MILL WORK MATERIALS

About 65 percent of the respondents that used materials for shelving and mill work, indicated that they used plywood. The primary

reasons for its selection were prices paid for materials and performance of material. As in cabinet work, the most desirable characteristic a material could have was workability. This was needed to reduce cost and time.

The mean price paid for delivered plywood was 14.7 cents per square foot and the mean price paid for plywood bought from the dealers yard was 13.1 cents per square foot. The ranges in prices paid were 8 to 30 cents for delivered plywood and 10 to 16 cents per square foot at the dealers yard. The modal price for delivered material was 15 cents per square foot and 14 cents per square foot dealers yard.

MOST COMMON OBJECTIONS TO AND RECOMMENDATIONS FOR IMPROVING PLYWOOD

All respondents were asked to relate their criticisms of plywood in the different end uses. These are summarized below.

Roof sheathing

It cannot be used for shakes.

Wall sheathing

It does not insulate well.

It requires more labor costs.

Soffits

It does not weather well.

It does not finish well.

Exterior siding

It does not weather well.

It requires more work and labor.

Subflooring

It is not solid and it requires a frame.

It requires more work than present material.

It is not durable.

It is susceptible to termites.

Underlayment

It is not commonly used -- a trend.

It is not durable.

Finish floor

It is not commonly used -- a trend.

It is not durable.

It does not finish well.

It does not have the customer appeal.

It is hard to maintain.

Form work

None

Decking

It is not strong enough.

Interior paneling

None

Cabinet work

It does not work well.

The price is too high.

Shelving and mill work

It does not finish well.

It does not work well.

The price is too high.

Durability and weatherability were the two most common objections to the use of plywood. Also, the fact that it is not commonly used and that the price was too high had significant response.

At the same time respondents offered criticisms of plywood they were asked for suggestions regarding characteristics which may make plywood more acceptable for different end uses. The suggestions which were repeated a significant number of times are listed below.

Roof sheathing

improve strength

Wall sheathing

increase nail holding ability

increase strength

Soffits

better weathering

Exterior siding

better weathering ability

improve factory treatment

Subflooring

increase strength

improve factory coating

Underlayment

None

Finish flooring

better finish

Decking

increase strength

make it thicker

Form work

improve coating

make stronger corners

Interior panel

increase tack ability

wider selection

Cabinet work

- reduce price
- increase nail holding ability
- more sizes

Shelving and millwork

- lower price
- increase strength
- more sizes

Increasing the strength and increasing the weathering ability were the two most frequently mentioned improvements which plywood should have. Other very frequently mentioned improvements were to improve the finish and lowering the price.

INTENTIONS FOR FUTURE MATERIAL USE

All of the respondents interviewed were asked to estimate whether or not they would increase or decrease the amount of plywood and competing material they would use in the future. Many of these estimates were based on their expectations regarding the general level of building activity rather than upon their intentions to alter materials used.

The majority of those respondents who presently used plywood thought that they would use the same amounts next year as they had done in the current year except for the end uses of decking and interior paneling (Table 45). Most of the firms using plywood in these latter uses expected to increase their use volume. In most end uses few respondents reported an expected decrease in their plywood usage.

More of those firms that were not plywood users expected to increase their consumption of these materials the next year than there were that expected to use the same amount except for subflooring, formwork, and decking. There were very few instances where the use of the present material was expected to decline.

TABLE 45. Intentions For Future Use of Materials In Different Applications, Arizona, 1968.

If you already use plywood, will you use plywood more or less next year?
Number of firms reporting:

<u>End Use</u>	<u>Increase</u>	<u>Same</u>	<u>Decrease</u>
Roof Sheathing	30	70	1
Wall Sheathing	12	46	
Soffits	6	24	4
Exterior Siding	7	3	
Subflooring		3	
Underlayment	2	16	
Finish Floor			
Form Work	43	103	4
Decking	3		
Interior Panel	54	21	2
Cabinet Work	13	48	4
Shelving & Millwork	10	43	6

If you are not using plywood, will you use your present material more or less next year?

Roof Sheathing	7	5	1
Wall Sheathing	19	16	3
Soffits	15	14	2
Exterior siding			
Subflooring	31	50	1
Underlayment	21	28	3
Finish Floor	40	27	2
Form work	1	3	
Decking	7	24	3
Interior Panel	8	8	0
Cabinet Work	25	10	3
Shelving & Millwork	17	12	0

STUDY PHASE FOUR DEPTH INTERVIEW OF PANEL GROUPS

The basic unique feature of this phase of the study was to promote group discussion between representatives of different segments of the construction industry. A panel moderator directed the conversation to include the type of information requested in the two party personal interviews. Control over discussion topics was sufficiently relaxed so as to allow discussion of extraneous topics introduced by panel participants. Such topics frequently enhanced understanding of industry problems and identified many factors not considered in the structured questionnaire, i. e., problems associated with plywood grading. Other procedures followed in conducting the panel sessions were briefly described at page 11 of this report.

Participants were selected from the list compiled during the prior phases of this project. It frequently required from 10 to 20 contacts to obtain one contractor or builder who would consent to participate in a panel group during the lunch hour. The greater disappointment was that approximately 60 percent of those who agreed to participate failed to show up for the panel discussion. However, it is anticipated that these problems could be greatly mitigated by working through trade associations, holding the interviews in conjunction with organized seminars related to the industry problems and perhaps conducting the sessions in the evening.

In spite of the sparse number of participants, the amount and type of information obtained vindicates this approach for gathering qualitative data. In addition, the relative cost of this method is small compared to the cost of personal interviewing large numbers of contractors and builders.

Some of the advantages claimed for group interviews are:

1. The base of communications is broadened since the interaction between individuals causes more ideas to be shared, discussed and evaluated than in a two person interview.
2. There is a lower threshold for personal revaluations so that a mutually sanctioned level of frankness is reached more readily than with an interviewer and a respondent.
3. The individual is more likely to respond in line with their normal behavior because of social inhibitions of the group.
4. Each individual usually tries hard to contribute information and express views as much as possible.
5. The use of a tape recorder provides an accurate method of evaluation from all points of view.

FINDINGS FROM PANEL INTERVIEWS

The information presented in this section reflect the opinions expressed by the panel participants. They ^{do not necessarily} ~~may or may not~~ represent opinions held by the authors or by employees of the U. S. Department of Agriculture.

Information revealed by the individuals who did participate in group panel discussions is interesting to note. The cost of truck transportation was one of the first general topics of concern revealed by groups not located in the immediate Phoenix area. They felt that it was impossible for most types of factories to locate in outlying areas of the state because high truck transportation costs eroded other forms of competitive advantages. The shipment of building materials by rail from Southeastern United States to Phoenix was purported to be less than the cost of trucking from Phoenix to Tucson. The utilization of empty box cars returning to California was stated to be the reason for this

transportation cost relationship.

One of the first complaints regarding the building industry in general was the problem of dealing with "halfway qualified factory representatives." It was also pointed out that this problem is not peculiar to plywood suppliers. There was particular concern expressed by both large and small contractors regarding delays in procurement of manufactured items--hardware in particular. Ninety day delays are not atypical.

There was considerable discussion regarding conflicts between architects and builders. The stated basic reason for this conflict was that architects are not particularly cost conscious and builders must stress this aspect. Architects are paid a percentage of the total value of the structure, therefore, it is not in their best interest to incorporate low cost materials. They frequently specify "odd ball materials" and it is up to the builders to locate them. Frequently material suppliers have never heard of some of the materials specified.

There was almost unanimous criticism of the "lumber" or wood industry for downgrading materials such as plywood, doors and structural lumber. This view was elaborated with the comment that plywood of AC grade used to have the A side unblemished. In today's AC grade one now finds patches on the A side and voids in the plys. Structural lumber was considered to have deteriorated even more drastically. The builders had to discontinue using Standard and Better Douglas Fir material and go to a higher construction grade. Time wasted in idle crews while waiting for lumber yards to replace bad lumber was too costly.

The view was expressed that there seemed to be a "conspiracy" among producers to keep builders confused about grades. The mills

grade their own products and this results in much of the problem because grades are changed with fluctuating supply and demand situations. That is, when supply is short mills tend to throw inferior products into higher grades and sell them at relatively high prices.

There may have been some misunderstanding about the grading system. Mills must produce to certain grade specifications in order to use the accepted grading stamps. Plywood that falls below these specifications is often sold under a mill grade. The statements of panel participants may have referred to these latter grades although this was not clarified in discussions.

It was not felt that the building trade had much to say about products developed. The only recourse was to not buy those products placed on the market which were too expensive or not functionally competitive. Plywood producers claim to have prefinished 12 foot panels but builders in the Arizona area must wait up to 12 months for delivery and the cost is "out of this world."

DISCUSSION OF SPECIFIC END USES FOR BUILDING MATERIALS

Formwork

Plywood is the primary material used for this purpose. The main reason for this is that plywood is cheaper than steel, the major alternative material. There are serious problems associated with plywood use, the major one being its tendency to chip or break at the corners. This is especially true when lumber framework is used and the carpenters do not use care in stripping the forms after concrete has been poured. Frequently, this material can be reused only two or three times. However, the panelists suggested that a normal reuse factor was eight times. To decrease damage in stripping forms, thin ply is used in steel frames which have attachments

for locking together. Plywood is replaced in the frames as it wears out.

The panel participants recognized that improvements are being made in material for this use. Reference was made to a product made in Finland called "thin form." It is a product which has 12 laminations of birch and is twice as strong as the regular plywood forms. It can be used up to 20 times with the proper surface coating and if care is used in stripping forms.

The reader will recognize that the few panel members identified the same qualitative factors responsible for using plywood in this end use as were identified by the personal interview respondents.

Roof Sheathing

In single family homes and smaller commercial buildings plywood is the principle material used for this purpose. "Native" (locally produced) 1 inch x 8 inch boards were once the primary material use for roof sheathing but labor costs for installation eliminated lumber as a competitive product, even though boards are produced locally and are relatively inexpensive. Plywood 1/2 inch to 3/4 inch thickness is now the primary product used. Tectum, an insulating board, is sometimes substituted for plywood. This information substantiates the opinion expressed in the previous section summarizing the personal interviews. The important consideration with regard to material cost is the total in place cost, not just material price.

Wall Sheathing

Panel participants agreed that very little plywood is used for this purpose mainly because of the relatively high cost of material and cost of application. Plywood paneling 1/8 inch thick is sometimes used to change the appearance of one wall. One-half inch drywall sheetrock is the primary material used because it is relatively inexpensive, 10 cents per

square foot, and it has no close competitor as far as installation cost is concerned. In addition, sheetrock is now available in 32 foot panels.

Thus, the race between material cost and labor cost continues. The dry-wall material has been improved greatly over the past 10 years until it is now used in place of plaster but most people do not recognize the difference.

After attending demonstration shows featuring new materials, some of the panel members expect the trade to start using plastic for the entire wall. Forms are built and the plastic is poured using any color desired. The material is strong and can be sawed, shipped, nailed, bolted, and screwed. One operation is all that is necessary and the need for painting and maintenance is eliminated.

Again, much of the same information obtained from the large number of personal interviews concerning this application was revealed by these few participants in depth panel interviews.

Exterior Siding

Concrete block was identified as the primary material used for this purpose in the Arizona area. Two important reasons were revealed to explain and justify the use of concrete block rather than plywood. One was the cost-factor--concrete block served as both an exterior and an interior surface in one application thus saving labor costs and additional material cost. A second important factor, encouraging the use of concrete block, is the effect that the weather has on wood products. Wood just does not hold up well in the sun rays and heat in this area and it requires considerable maintenance. The opinion was also expressed that most of the wood products are of low quality today. Again, the information obtained is similar to that revealed in the personal interview phase of this study

but panel groups explained more clearly why this was the case.

Underlayment

The material used for this purpose is primarily concrete slab. Carpeting was then placed on this to cushion the material.

CONCLUSIONS

The use of two methods of study on the construction population pointed up some items of interest. Tests of the data from principal contractors of nonresidential construction showed that those firms contacted by the personal interview method were, on the average, larger users of softwood plywood. However, when plywood use was considered by specific application, firms in the personal interview sample were larger users of plywood than firms in the mail questionnaire sample only for roof sheathing and floor underlayment. Use of plywood for other applications was similar for both of the samples.

Comparisons of data by principal contractors of residential construction for both of the methods showed no significant differences between the two. The amounts of plywood used per builder for each application were not significantly different except for plywood usage in wall paneling.

Subcontractors of nonresidential construction had a significant difference between the two samples in plywood usage only for roof sheathing, floor underlayment, and formwork. Firms of the mail questionnaire sample were larger users for these three applications. Average plywood used for the other applications and for total plywood used per builder showed no significant difference.

Subcontractors of residential construction in the two respective samples had a significant difference in plywood usage for subflooring and siding only. Like the nonresidential subcontractors, firms in the mail questionnaire sample used larger amounts for these two applications. The use of confidence intervals on data from both methods did not provide conclusive evidence that either sample would lead to different conclusions. The size of the intervals for mean plywood usage in specific applications

was very large in most cases for both methods of data collection.

The marketing systems through which plywood moved within the study area were evident from the study. By far the largest amounts of plywood used by the user groups came through conventional market channels within the study area. Most plywood was purchased from wholesale and retail dealers who were located inside the area. In the case of the construction population there was some variation among the size classes of firms as to where plywood was obtained. In particular, the largest contractors had a tendency to purchase considerable amounts of plywood from producing mills or dealers outside the study area, while smaller contractors and subcontractors usually purchased the largest share of plywood moved through other channels of distribution to contractors. Plywood used by manufacturers came primarily from dealers inside the study area. Channels through which plywood moved were shown best by the data from the wholesale and retail dealers who responded to the mail questionnaire. The share of the plywood that was purchased by the farm and ranch, do-it-yourself and miscellaneous markets was considerable. The present study showed that about 25 percent of the total plywood went into these markets which was more than anticipated. The D. F. P. A. study did not show statistics that support this result.

Some idea of the changing trends in plywood usage were shown by a comparison of the average amount of plywood used per square foot of floor area for single family home construction. The usage of plywood in homes inspected by F. H. A. was 1.18 square feet per square foot of

²⁰Op. Cit. D. F. P. A.

floor area.²¹ This study showed the average to be 1.64 sq. ft. of plywood per square foot of floor area in single family homes. The average amount of softwood plywood used per single family home in 1962 in the Southwest was 1500 sq. ft.²² This study showed the average amount used in Arizona during 1966 to be 2,796 sq. ft. Evidently there was a tendency to use plywood for more applications or to use more plywood for a given application.

RECOMMENDATIONS FOR GATHERING QUANTITATIVE DATA

Based on the results of phases one and two of this study, it may be advisable to alter the approach to data collection. The methods used for this study were explained at pages 7 to 10 . A possible alternative method is as follows:

- a. Send the regular questionnaires to all firms engaged in manufacturing mobile homes, prefabricated home manufacturing, manufacturing of wood products, and to wholesale and retail lumber distributors. If the response from these populations is unsatisfactory, a selected sample of nonrespondents, should be contacted by telephone and attempts made to determine reasons for nonresponse and procure the information requested.
- b. Send the regular classification questionnaire to all construction firms listed for this population just as was done in this study. Stratify the returns from this questionnaire by type and size of contractor and then select a sample to receive the detailed mail questionnaire from each of the strata. However, since

²¹ Op. Cit. U. S. D. A. Statistical Bulletin No. 366.

²² Ibid.

it was found in this study that the large firms respond better to personal interviews, it is suggested that the largest firms in each construction category be contacted personally or interviewed by telephone. There is some question whether or not the additional data obtained from personal interviews, regarding quantitative data, justifies the considerable cost of this method. The mailed questionnaire returns seemed to reveal the general plywood use patterns.

CRITIQUE OF PERSONAL INTERVIEWS TO OBTAIN QUALITATIVE DATA

Invaluable information relating to the reasons for using the different materials was obtained in this phase of the study. However, there are problems associated with the methodology utilized. Of first concern is the problem related to gaining respondent participation after they had previously been contacted with at least two different mail questionnaires. It is too much to expect high level management to participate more than once in any one study. Especially when there is little direct relationship between study objectives and problem solving for any individual firm.

Another problem experienced in the personal interview field work was associated with the bulkiness of the questionnaires themselves. The enumerators sometimes had difficulty conducting well executed interviews because of all the paper shuffling required. This problem could probably be overcome by redesigning the questionnaire format and eliminating questions which do not materially add to information already obtained in other parts of the questionnaire.

There seemed to be additional problems associated with the structured questionnaire. Responses to questions concerning the different end uses for plywood and substitute materials tended to be

repetitive. There seemed to be some constraint which restricted responses to a superficial level. There appeared to be little opportunity to explore in depth the "real" reasons for use of specific materials. Of course, much detail is lost in aggregating and summarizing data.

If it is considered essential to conduct two party personal interviews to determine qualitative information, it seems advisable to obtain the quantitative data requested in the detailed mail questionnaires at the same time. The procedures for the construction population would then be to (1) send all firms the short classification questionnaire; (2) select the sample for mailing the detailed questionnaires; (3) select the sample for the personal interview questionnaires; (4) where the same firms are selected for both questionnaires obtain all information at one time through a personal visit or telephone interview. Do not attempt to procure data by mail and then attempt to obtain qualitative data by personal interview at a later date.

If personal interviews are conducted, the questions regarding qualitative use factors should be left more "open ended." Respondents probably should not be shown the suggested reasons for explaining the use of materials, rather, the enumerators should make these classifications after those interviewed state their own conceived reasons.

CRITIQUE OF THE PANEL GROUP INTERVIEW METHOD

The results from this method for obtaining qualitative information regarding the construction industry, provide many indications that the results are superior to the two party personal interview method. Greater insight into industry problems was achieved and it was possible to draw many of the same conclusions regarding different materials. This was accomplished at a considerably lower cost and with less professional effort.

If panel participants are carefully selected from different industry groups (including architects and building code enforcement agencies), different size operations, and different locations this method could eliminate the need for interviewing large numbers of firms. The net result would also probably be a much more informative study. Additional factors favoring this method are that fewer interviewees would be involved and the environment in which questioning is conducted would be more standardized.

This would probably reduce the variation in responses associated with such factors. There would also be considerably less likelihood for panel moderators to suggest answers to different questions.

The in depth panel interviews should be investigated and tested more completely before major efforts are made to personally interview large numbers of firms to obtain qualitative information in other study areas.

BIBLIOGRAPHY

- Douglas Fir Plywood Association. A Study of Markets and Uses for Softwood Plywood. Volumes I and II. February 1963.
- Li, Jerome C. R. Statistical Inference I. Edwards Brothers, Inc. Ann Arbor, Michigan. 1964.
- Manetsch, T. J. Simulation and Systems Analysis of the United States Softwood Plywood Industry. Ph.D. Thesis. Oregon State University. 1965.
- Petit, T. A. "The Value of Competition", in Journal of Industrial Economics. Volume 6. 1957.
- Simpson, R. S. An Econometric Analysis of Demand and Supply Relationships in the Douglas Fir Plywood Industry. Master's Thesis. Oregon State University. 1963.
- United States Department of Agriculture, Forest Service. Wood Used in Manufacturing Industries. Statistical Bulletin No. 355. February 1965.
- United States Department of Agriculture, Forest Service. Wood Products Used in Single Family Houses Inspected by the Federal Housing Administration, 1959 and 1962. Statistical Bulletin No. 366. March 1966.
- United States Department of Commerce. Supplement to Survey of Current Business--Business Statistics 1967. Biennial Edition. Office of Business Economics.
- United States Department of Commerce. United States Industrial Outlook, 1966. Business and Defense Services Administration. December 1965.
- "U. S. Plywood Shoots for Total Product Use", in Forest Industries Journal. Volume 93, No. 1. January 1966.
- Yerkes, Vern P., Lloyd, R. Duane, and Lewis, Gordon D. Softwood Plywood Production in the U. S. - Production and Distribution in 1965. United States Forest Service Res. Pap. RM-34. 1966.

*Personal Interview Questionnaire***III. Specific Applications**
INTERVIEWER: COMPLETE ONE SET FOR EACH APPLICATION

Name of Firm _____

 Application¹

1. Does the material you select for this use vary with:

a. Style of house?

☐

No

☐

Yes

How? _____

Why? _____

b. Location of house?

☐

No

☐

Yes

How? _____

Why? _____

c. Price of house?

☐

No

☐

Yes

How? _____

Why? _____

2. You indicated that you made the final selection of the materials used for (application) _____ and that you selected this material because of 1st Reason _____, 2nd Reason _____, 3rd Reason _____. I would like to ask some questions about your reasons for selecting this material.

INTERVIEWER: GO TO THE INDICATED REASONS FOR SELECTING MATERIALS

¹ Interviewer will fill in from Question 1, Section II. Indicate with a (P) if respondent uses plywood in this application and with a (O) if materials other than plywood are used.

Reason a
Respondent _____

a. Prices paid for materials

(1) General:

(a) How much are you now paying for your material?
(unit of purchase)

(b) Is this price for the material delivered on-site, f. o. b.
rail siding, f. o. b. dealer's yard, etc. ?

(2) If plywood is not used:

(a) What would plywood cost for this application if bought
the same way?

(b) At what price would you buy plywood for this use?

(3) If plywood is used:

(a) What other substitute materials have you considered using?

(b) How much would these materials cost if bought in the same wa

Reason b

Respondent _____

b. Cost of installation**(1) General:**

- (a) What does it cost to install your present material in this application? (specify unit of measure)

(2) If plywood is not used:

- (a) What would it cost to install plywood?
(specify unit of measure)

- (b) Why is the one more expensive than the other?

(3) If plywood is used:

- (a) How much does it cost to install other materials you have considered for this use?

Reason c
Respondent _____

c. Reputation of manufacturer

(1) General:

(a) Do you order the material you now use by brand name?

☐ Yes ☐ No

(b) Do you order your material directly from manufacturer?

☐ Yes ☐ No

(2) If plywood is not used:

(a) Have you ever tried to buy plywood directly from a given manufacturer or by brand name?

☐ Yes ☐ No

(b) If yes, what happened?

(3) If plywood is used:

(a) Who produces the plywood you now use?

(b) Why is it superior to that produced by others?

Reason d
Respondent _____

d. Guarantees and warranties

- (1) What guarantees and warranties do your present materials have?

- (2) Do you find these guarantees and warranties necessary in this application? Why?

☐ Yes ☐ No

- (3) Would you do without such warranties and guarantees if the price were reduced?

☐ Yes ☐ No

- (4) If no, how much of a reduction would you consider necessary to do without guarantees and warranties?

e. Credit and financing

- (1) Who grants the credit and financing for the materials you now use for this application?

- (2) What kinds of credit and financing do you now receive?

- (3) Is this credit and financing available for all materials suitable for this application?

☐ Yes ☐ No

- (4) If no, what materials can be purchased with the same credit and financing?

Reason f
Respondent _____f. Manufacturer and distributor assistance (on-site delivery, precutting, packaging, etc.)

(1) General:

- (a) What assistance and services do the manufacturers or distributors of your present material offer?

(2) If plywood is not used:

- (a) Do plywood manufacturers or distributors offer assistance and services?

☐ Yes ☐ No

If yes:

How does this assistance and service differ from those you now receive?

If no:

Would you consider using plywood if the plywood manufacturers and distributors provided assistance and services similar to that you now receive?

☐ Yes ☐ No(3) If plywood is used:

- (a) Do manufacturers and distributors of other materials offer assistance and services?

☐ Yes ☐ No

Reason g
Respondent _____

g. Ease of procurement

- (1) For the material you are now using, what is the usual time period between ordering and delivery?
-

- (2) Is the delivery time for other materials longer or shorter?

☐ Longer ☐ Shorter

Reason h
Respondent _____

h. Building Code, FHA, VA, etc., requirements

(1) Is the material you use for this application dictated by building codes, etc?

☐ Yes

☐ No

(2) Have you ever attempted to get another material accepted for this use by code, FHA, or other officials?

☐ Yes

☐ No

If yes:

What materials were involved?

Were you successful?

☐ Yes

☐ No

What problems did you encounter?

i. Performance

(1) General:

- (a) What are the characteristics of your present material that make it more suitable for this use than other materials?

- (b) Why do you need these characteristics?

(2) If plywood is not used:

- (a) Which of these characteristics are missing in plywood?

Reason j
Respondent _____

j. Ease and durability of finishing

(1) What type of finish do you most frequently apply?

(2) How is the material you are now using more suitable for this finishing than other materials?

Reason k
Respondent _____

k. Customer preference (fashions, fads, etc.)

- (1) What characteristics of the material you are now using makes it preferred by your customers over other materials in this application?

- (2) Do you have to change the materials used in this application frequently because of changes in customer preference?

☐ Yes ☐ No

- (3) How do you determine when customer preferences are changing?

Reason 1
Respondent _____

1. Architectural appearance

(1) General:

- (a) How does the material you use in this application create a better architectural appearance than other materials?

(2) If plywood is not used:

- (a) How does plywood fail to provide this appearance?

Reason m
Respondent _____

m. Other (specify)

- (1) What characteristics of the product you use makes it more suitable for this application than competing materials?

3. What other advantages are there in using this material for this application?

4. If plywood is not used, what are the major disadvantages of using plywood in this application? (Omit this question if plywood is used.)

5. Do you expect that the total yearly use of your present material for this application will increase, decrease, or remain the same in the next 2 to 5 years? Why?

INTERVIEWER: PROBE FOR SUCH THINGS AS:

WILL BUILD MORE HOUSES, WILL INSIST ON MORE USE
OF PRESENT MATERIALS, COST WILL CAUSE CHANGE
TO OTHER MATERIAL (What material?), NEW MATERIAL
WILL REPLACE PRESENT MATERIALS, ETC.

6. How could plywood be made more suitable for use in this application?

APPENDIX II

Percents and Amounts of Hardwood Plywood
Used in Non Residential and Apartment Construction
by Size Classes of Contractors, Arizona, 1966.

a) Mail Questionnaire

Type of Structure	Value of Constr. \$100,000		Value of Constr. \$100,000 to \$1 Mill.		Value of Constr. \$1,000,000	
	Total Amt. Sq. Ft.	% of Total	Total Amt. Sq. Ft.	% of Total	Total Amt. Sq. Ft.	% of Total
High-Rise Apts.	None	---	800	4.6	None	---
Garden Apts.	None	---	None	---	None	---
Non-Resid. Bldgs.						
Educ. Facilities	None	---	2,300	13.1	None	---
Priv. & Gov't. Offices	4,000	48.8	600	3.4	None	---
Commercial Buildings	3,200	39.	3,800	21.7	1,000	100
Warehouses	None	---	2,000	11.4	None	---
Other	1,000	12.2	8,000	45.7	None	---
Non-Bldg. Constr.						
Bridge & Highway	None	---	None	---	None	---
Formwork	None	---	None	---	None	---
Other	None	---	None	---	None	---
Totals	8,200	100	17,500	100	1,000	100

APPENDIX II Cont.

Percents and Amounts of Hardwood Plywood
Used in Non Residential and Apartment Construction
by Size Classes of Contractors, Arizona, 1966.

b) Personal Interview

Type of Structure	Value of Constr. \$100,000		Value of Constr. \$100,000 to \$1 Mill.		Value of Constr. \$1,000,000	
	Total Amt.	% of	Total Amt.	% of	Total Amt.	% of
	Sq. Ft.	Total	Sq. Ft.	Total	Sq. Ft.	Total
High-Rise Apts.	None	---	21,700	12.45	3,250	50.00
Garden Apts.	None	---	None	---	None	---
Non-Resid. Bldgs.						
Educ. Facilities	None	---	None	---	None	---
Priv. & Gov't. Offices	1,050	4.99	152,528	87.55	3,250	50.00
Commercial Buildings	20,000	95.01	None	---	None	---
Warehouses	None	---	None	---	None	---
Other	None	---	None	---	None	---
Non-Bldg. Constr.						
Bridge & Highway	None	---	None	---	None	---
Formwork	None	---	None	---	None	---
Other	None	---	None	---	None	---
Totals	21,050	100	174,228	100	6,500	100

APPENDIX II Cont.

Table 13-c. Percents and Amounts of Hardwood Plywood
Used in Non Residential and Apartment Construction
by Size Classes of Contractors, Arizona, 1966.

c) Combined

Type of Structure	Value of Constr. \$100,000		Value of Constr. \$100,000 to \$1 Mill.		Value of Constr. \$1,000,000	
	Total Amt. Sq. Ft.	% of Total	Total Amt. Sq. Ft.	% of Total	Total Amt. Sq. Ft.	% of Total
High-Rise Apts.	None	----	22,500	11.74	3,250	43.33
Garden Apts.	None	----	None	----	None	----
Non-Resid. Bldgs.						
Educ. Facilities	None	----	2,300	1.20	None	----
Priv. & Gov't. Offices	5,050	17.26	153,128	79.87	3,250	43.33
Commercial Buildings	23,200	79.32	3,800	1.98	1,000	13.33
Warehouses	None	----	2,000	1.04	None	----
Other	1,000	3.42	8,000	4.17	None	----
Non-Bldg. Constr.						
Bridge & Highway	None	----	None	----	None	----
Formwork	None	----	None	----	None	----
Other	None	----	None	----	None	----
Totals	29,250	100	191,728	100	7,500	100

Appendix III

Ninety Percent Confidence Intervals for the Amounts of Softwood Plywood Used in Specific
End Uses by Principal Contractors of Apartment and Non Residential Construction,
Arizona, 1966.¹

a) Mail Questionnaire Sample

	<u>Small Firms</u>		<u>Middle Sized Firms</u>		<u>Large Firms</u>		<u>Total</u>	
	Aver.	Sq.Ft.	Aver.	Sq.Ft.	Aver.	Sq.Ft.	Aver.	Sq.Ft.
Roof Sheathing	2,102	± 2,119	17,161	± 1,646	36,503	± 8,685	17,753	± 20,622
Roof Decking	460	± 815	2,758	± 3,774	4,762	± 85,660	2,584	± 2,894
Wall Sheathing	307	± 544	1,667	± 2,898	---	---	765	± 1,148
Subflooring	---	---	1,125	± 1,956	---	---	450	± 707
Soffits	---	---	875	± 1,522	3,155	± 5,675	1,233	± 1,605
Siding	26	± 50	1,613	± 2,957	2,103	± 4,086	1,242	± 1,462
Paneling	877	± 1,099	2,129	± 2,653	---	---	1,132	± 1,052
Formwork	234	± 433	7,690	± 10,116	20,764	± 19,909	8,965	± 6,536
Other	88	± 166	753	± 1,379	---	---	329	± 515
Total	4,093	± 1,955	35,770	± 20,033	67,286	± 26,336	34,458	± 12,779

Appendix III(continued)

b) Personal Interview Sample

	<u>Small Firms</u>		<u>Middle Sized Firms</u>		<u>Large Firms</u>		<u>Total</u>	
	Aver.	Sq.Ft.	Aver.	Sq.Ft.	Aver.	Sq.Ft.	Aver.	Sq.Ft.
Roof Sheathing	28,666	± 61,528	38,686	± 33,912	140,416	± 113,915	74,056	± 43,811
Roof Decking	---	---	15,625	± 17,662	---	---	6,579	± 764
Wall Sheathing	---	---	4,725	± 8,205	1,429	± 2,570	2,515	± 3,515
Subflooring	---	---	275	± 487	---	---	116	± 200
Underlayment	10,000	± 645	3,186	± 5,647	286	± 514	3,552	± 4,196
Soffits	---	---	1,667	± 2,954	2,857	± 5,140	1,754	± 2,136
Formwork	1,333	± 3,137	800	± 1,516	46,529	± 19,520	17,760	± 21,242
Paneling	---	---	333	± 200	---	---	140	± 243
Other	2,400	± 5,647	2,000	± 3,790	---	---	1,347	± 1,656
Total	42,396	± 81,774	67,296	± 33,874	191,517	± 71,552	107,820	± 38,396

Appendix III (continued)

c) Combined Data

	<u>Small Firms</u>		<u>Middle Sized Firms</u>		<u>Large Firms</u>		<u>Total</u>	
	Aver.	Sq.Ft.	Aver.	Sq.Ft.	Aver.	Sq.Ft.	Aver.	Sq.Ft.
Roof Sheathing	2,988	± 15,765	10,934	± 15,272	28,146	± 57,344	42,068	± 20,129
Roof Decking	84	± 554	3,468	± 7,694	758	± 4,212	4,309	± 3,371
Wall Sheathing	56	± 376	1,238	± 3,907	227	± 1,719	1,521	± 1,602
Subflooring	---	---	306	± 316	---	---	306	± 439
Underlayment	909	± 5,986	579	± 2,465	46	± 261	1,534	± 1,829
Soffits	---	---	502	± 1,499	956	± 3,623	1,458	± 1,254
Siding	5	± 31	367	± 1,559	335	± 1,862	706	± 826
Paneling	160	± 715	545	± 1,438	---	---	704	± 605
Formwork	164	± 813	1,839	± 5,449	10,706	± 29,095	12,763	± 9,580
Other	234	± 1,431	535	± 1,670	---	---	769	± 804
Total	4,599	± 3,280	20,365	± 18,085	41,173	± 45,226	66,137	± 19,749

¹A 90% Confidence Interval will contain the true population mean 90% of the time.

Appendix IV

Results of Tests of Significance of the Difference of the Populations from Which the Mail Sample and the Personal Interview Sample Were Taken

	Principal Cont. Non Res. ¹	Principal Cont. Res. ²	Sub Cont. Non Res. ³	Sub Cont. Residential ⁴	Principal Cont. Residential ⁵
Roof Sheathing	-2.1645*	- 1.32928	5.922*	- .75441	.00678
Roof Decking	- .9287	---	.592	- .53108	---
Wall Sheathing	- .9094	- 1.50915	.58543	- .53082	-.00943
Underlayment	-1.6852*	- .07213	5.92192*	---	.0027
Soffits	- .3429	- 1.63855	---	---	-.01124
Siding	1.2244	---	---	4.0625	---
Subflooring	.6217	1.25192	---	2.05882*	.09554
Paneling	1.3839	-15.22727*	---	- .52504	-.22727
Formwork	- .20832	---	3.805*	- .39168	---
Finish Floor	---	1.09059	---	---	-.0581
Other	-1.07896	- 1.52528	.05343	.69926	-.02588
Total	-3.4746*	- 1.51261	.10362	.86296	.00279
Construction Characteristics					
Solid Masonry		- .34334			
Wood Frame		- 1.36363			
Mixed Frame		- 1.27232			
One Story		- 1.71806*			
Total Houses		- 1.75965*			

¹t = \pm 1.684; d.f. = 43

²t = \pm 1.671; d.f. = 71

³t = \pm 1.8333; d.f. = 9

⁴t = \pm 1.796; d.f. = 11

⁵Significant difference of the mean amt./house.

⁶Negative values denote that the mean of the Personal Interview Population was larger, though not necessarily significantly larger.

*Significant difference at 90% level.

APPENDIX V

Specific End Uses for Hardwood Plywood in Apartment and
Non Residential Construction by Size Classes of Principal
Builders, Arizona, 1966.

a) Mail Questionnaire

Contractor Size - Dollar Value of Construction

Uses	Less than \$100,000			\$100,000-\$1 Million			Over \$1 Million		
	Amount (sq.ft.)	% of Total	Average /Bldr. (sq.ft.)	Amount (sq.ft.)	% of Total	Average /Bldr. (sq.ft.)	Amount (sq.ft.)	% of Total	Average /Bldr. (sq.ft.)
Wall Paneling	4,840	59	605	12,000	68.6	1,200	1,000	100	143
Cabinet Work	3,360	41	420	3,100	17.7	310	---	---	---
Finish Flooring	---	---	---	2,400	13.7	240	---	---	---
Totals	8,200	100	1,025	17,500	100	1,750	1,000	100	143

b) Personal Interview

Wall Paneling	21,050	100	5,263	174,228	100	21,786	6,500	100	929
Cabinet Work	None	---	---	None	---	---	None	---	---
Finish Flooring	None	---	---	None	---	---	None	---	---
Totals	21,050	100	5,263	174,228	100	21,786	6,500	100	929

c) Combined

Wall Paneling	25,890	88.51	2,158	186,228	97.13	10,346	7,500	100	536
Cabinet Work	3,360	11.49	280	3,100	1.62	172	None	---	---
Finish Flooring	None	---	---	2,400	1.25	133	None	---	---
Totals	29,250	100	2,438	191,728	100	10,652	7,500	100	536

Appendix VI

Confidence Intervals
Ninety Percent Confidence Intervals for the Amounts of Softwood
Plywood Used in Specific End Uses by Sub Contractors,
Arizona, 1966.¹

Sub Contractors: Non Residential Construction

	Mail Sample		Personal Interview Sample		Combined	
	Aver.	Sq.Ft.	Aver.	Sq.Ft.	Aver.	Sq.Ft.
Roof Sheathing	10,416	± 19,739	---	---	7,576	± 4,341
Roof Decking	833	± 1,579	---	---	606	± 1,098
Wall Sheathing	3,906	± 7,402	---	---	2,841	± 515
Underlayment	3,125	± 5,922	---	---	2,273	± 4,119
Formwork	67,061	± 62,534	---	---	48,772	± 45,968
Other	4,383	± 5,820	4,089	± 9,701	4,303	± 4,212
Totals	9,725	± 60,995	4,089	± 9,701	66,370	± 47,023

Sub Contractors of Single Family Homes

Roof Sheathing	18,666	± 7,914	71,131	± 67,579	59,024	± 51,268
Roof Decking	---	---	1,530	± 2,805	1,177	± 2,097
Subflooring	378	± 1,103	---	---	87	± 161
Wall Sheathing	---	---	595	± 1,091	458	± 816
Siding	1,222	± 1,807	---	---	282	± 342
Paneling	---	---	653	± 977	502	± 895
Formwork	139	± 406	533	± 977	442	± 729
Other (Cabinets)	---	---	4,287	± 5,968	3,298	± 4,504
Totals	20,405	± 22,119	78,729	± 65,693	65,270	± 5,020

¹ A 90% Confidence Interval will contain the true population mean 90% of the time.

Appendix VII

Specific End Uses for Hardwood Plywood in Apartment
and Non Residential Construction by Sub Contractors,
Arizona, 1966.

a) Mail Questionnaire

Uses	Most Usual Specie	Total Amt. Sq. Ft.	Aver. Amt. Sq. Ft.
Wall Paneling		1,200	150
Cabinet Work	Mahog., Birch, Ash	140,000	17,500
Finish Flooring		None	-----
Other #1		None	-----
#2		None	-----
#3		None	-----
Total Amount Used		141,200	17,650

b) Personal Interview

Wall Paneling	Walnut	6,400	2,133
Cabinet Work		None	-----
Finish Flooring		None	-----
Other #1		None	-----
#2		None	-----
#3		None	-----
Total Amount Used		6,400	2,133

c) Combined

Wall Paneling	Walnut	7,600	691
Cabinet Work	Mahog., Birch, Ash	140,000	12,727
Finish Flooring		None	-----
Other #1		None	-----
#2		None	-----
#3		None	-----
Total Amount Used		147,600	13,418

Appendix VIII

Sources of Hardwood Plywood Used by Principal Contractors
of Single Family Homes, Arizona, 1966.

a) Mail Questionnaire								
Sources ¹	Contr. Bldg. From 1 to 10 Homes		Contr. Bldg. From 11 to 50 Homes		Contr. Bldg. Over 50 Homes		Total Amt. From Each Source	% of the Total From Each Source
	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total	Amt. in Sq. Ft.	% of Total		
From Mills:								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
From Wholesale or Retail Dlr.								
In Study Area	45,990	59.95 (25.25)	104,170	100 (57.19)	32,000	100 (17.57)	182,160	85.57
Outside Study Area	30,720	40.05 (100)	None	---	None	---	30,720	14.43
Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Total Amount Purchased	76,710	100	104,170	100	32,000	100	212,880	100
b) Personal Interview								
From Mills:								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
From Wholesale or Retail Dlr.								
In Study Area	3,780	100 (3.38)	79,240	100 (70.86)	28,800	100 (25.76)	111,820	100
Outside Study Area	None	---	None	---	None	---	None	---
Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Total Amount Purchased	3,780	100	79,240	100	28,800	100	111,820	100
c) Combined								
From Mills:								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
From Wholesale or Retail Dlr.								
In Study Area	49,770	61.83 (16.93)	183,410	100 (62.39)	60,800	100 (20.68)	293,980	90.54
Outside Study Area	30,720	38.17 (100)	None	---	None	---	30,720	9.46
Other Sources								
In Study Area	None	---	None	---	None	---	None	---
Outside Study Area	None	---	None	---	None	---	None	---
Total Amount Purchased	80,490	100	183,410	100	60,800	100	324,700	100

Appendix IX

Ninety Percent Confidence Intervals for the Amounts of Softwood Plywood Used in Specific End Uses by Principal Contractors of Single Family Home Construction, Arizona, 1966.¹

<u>Type of House</u>	<u>Mail Sample</u>	<u>Interview Sample</u>	<u>Combined Data</u>
Solid Masonry	18 \pm 30	26 \pm 14	21 \pm 7
Wood Frame	1 \pm .6	4 \pm 5	2 \pm 2
Mixed Frame	.5 \pm .5	29 \pm 49	12 \pm 18
One Story	19 \pm 7	58 \pm 48	34 \pm 19
Total	19 \pm 7	60 \pm 49	35 \pm 19

a) Mail Questionnaire Sample

	<u>Small Firms</u>		<u>Middle Sized Firms</u>		<u>Large Firms</u>		<u>Total</u>	
	<u>Aver.</u>	<u>Sq.Ft.</u>	<u>Aver.</u>	<u>Sq.Ft.</u>	<u>Aver.</u>	<u>Sq.Ft.</u>	<u>Aver.</u>	<u>Sq.Ft.</u>
Subflooring	2,649 \pm	1,711	896 \pm	1,287	750 \pm	1,765	1,896 \pm	1,053
Underlayment	1,537 \pm	1,255	896 \pm	1,418	---	---	1,187 \pm	822
Finish Floor	551 \pm	676	---	---	---	---	319 \pm	388
Soffits	210 \pm	173	1,779 \pm	2,204	750 \pm	1,765	781 \pm	723
Roof Sheathing	8,873 \pm	2,068	57,754 \pm	15,180	303,389 \pm	214,099	51,346 \pm	24,538
Wall Sheathing	498 \pm	353	3,257 \pm	2,360	17,256 \pm	23,747	2,907 \pm	1,931
Total	14,319 \pm	2,795	64,581 \pm	15,404	322,145 \pm	238,274	58,435 \pm	26,010

Appendix IX (continued)

b) Personal Interview Sample

	<u>Small Firms</u>		<u>Middle Sized Firms</u>		<u>Large Firms</u>		<u>Total</u>	
	Aver.	Sq.Ft.	Aver.	Sq.Ft.	Aver.	Sq.Ft.	Aver.	Sq.Ft.
Subflooring	1,513 ±	1,777	---	---	---	---	756 ±	892
Underlayment	1,500 ±	2,438	4,333 ±	7,638	---	---	1,988 ±	2,368
Roof Sheathing	20,674 ±	15,221	64,470 ±	27,055	499,662 ±	801,537	135,827 ±	130,348
Wall Sheathing	2,479 ±	2,455	15,558 ±	27,399	33,333 ±	78,432	12,827 ±	13,878
Soffits	---	---	12,424 ±	11,170	---	---	3,550 ±	3,429
Wall Panel	133 ±	191	---	---	---	---	67 ±	95
Other	343 ±	437	6,711 ±	3,947	977 ±	2,298	2,298 ±	3,230
Total	26,641 ±	19,634	103,496 ±	14,577	533,972 ±	809,236	157,313 ±	133,120

c) Combined Data

Subflooring	2,251 ±	1,249	584 ±	824	300 ±	550	1,459 ±	7,712
Underlayment	1,525 ±	1,128	209 ±	2,674	---	---	1,494 ±	1,025
Roof Sheathing	13,004 ±	5,497	60,090 ±	13,011	421,153 ±	370,297	83,750 ±	51,895
Wall Sheathing	1,191 ±	893	7,536 ±	24,334	26,902 ±	36,238	6,712 ±	5,437
Soffits	136 ±	386	5,482 ±	4,300	300 ±	550	1,843 ±	1,389
Finish Floor	358 ±	436	---	---	---	---	196 ±	238
Wall Panel	47 ±	66	---	---	---	---	46 ±	36
Other	120 ±	153	2,334 ±	4,007	586 ±	1,074	881 ±	1,235
Total	18,632 ±	7,267	78,117 ±	19,058	449,241 ±	375,624	96,361 ±	53,388

¹ A 90% Confidence Interval will contain the true population mean 90% of the time.

Appendix X

Specific End Uses for Hardwood Plywood in Single Family Home Construction by Sub Contractors, Arizona, 1966.

a) Mail Sample

Use	Total Amt. Sq. Ft.	Aver. Amt. Sq. Ft.	% of Total Ply. Used	Most Usual Species
Wall Paneling	1,500	500	65.2	Birch
Cabinet Work	800	267	34.8	Birch
Total Amt. Used	2,300	767	100	

b) Personal Interview

Wall Paneling	14,840	1,484	48.12	
Cabinet Work	16,000	1,600	51.88	Birch
Total Amt. Used	30,840	3,084	100	

c) Combined Data

Wall Paneling	16,340	1,257	49.31	Birch
Cabinet Work	16,800	1,292	50.69	Birch
Total Amt. Used	33,140	2,549	100	